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FIFTY–NINTH REPORT OF THE STATE GEOLOGIST (1963–66)

IAN CAMPBELL
State Geologist and Chief,
Division of Mines and Geology

CALIFORNIA DIVISION OF MINES AND GEOLOGY
Ferry Building, San Francisco, 1967

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Fifty-Ninth Report

of the

State Geologist

ACTIVITIES OF THE STATE DIVISION OF MINES AND GEOLOGY

July, 1963, through June, 1966

Ian Campbell

State Geologist and Chief, Division of Mines and Geology

Ferry Building, San Francisco

July 1963 through June 1966

STATE OF CALIFORNIA ▪ THE RESOURCES AGENCY ▪ DEPARTMENT OF CONSERVATION ▪ DIVISION OF MINES AND GEOLOGY

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ATE OF CALIFORNIA—THE RESOURCES AGENCY EDMUND G. BROWN, Governor

PARTMENT OF CONSERVATION
VISION OF MINES AND GEOLOGY
RY BUILDING, SAN FRANCISCO 94111

nch Offices:

SACRAMENTO
Resources Bldg., Rm. 118
1416 Ninth Street
95814

LOS ANGELES
Junipero Serra Bldg., Rm. 1065
107 South Broadway
90012

REDDING
State Bldg., Rm. 10
2135 Akard Avenue
96001

December 28, 1966

HON. IAN CAMPBELL, DIRECTOR
Department of Conservation
Sacramento, California

Sir:

I have the honor to transmit herewith the 59th Report of the Chief, Division of Mines and Geology, summarizing the activities of the Division from July 1, 1963, to June 30, 1966--during that period operating under DeWitt Nelson, Director, Department of Conservation, and Dr. Ian Campbell, Chief, Division of Mines and Geology. Cooperative programs with the U.S. Bureau of Mines, the U.S. Geological Survey, and other agencies are included.

Parts of this report were sent to the Director as annual reports for fiscal 1963-64 and 1964-65; the present combined form is for statutory distribution to State officials and agencies and to public libraries.

During the triennium, the first published products of the geophysical and geochemical investigations programs, first implemented in 1960-61, were released as technical papers.

The passage of legislation (SB 703) in 1965 enabled and encouraged the Division to reorient its program to increase emphasis on investigations of geologic hazards such as earthquakes and landslides. For the first time in its 86-year history, the Division was empowered to perform detailed local studies of geologically hazardous conditions in financial cooperation with local jurisdictions--successful programs are underway with Los Angeles County and with the City of San Diego.

The enlargement of its range of functions brings the Division ever closer to operating in the expanded concept of a fully capable geological survey of California, answering the many needs of the State for geological knowledge and advice.

Respectfully submitted,

Gordon B. Oakeshott

Gordon B. Oakeshott, Chief
Division of Mines and Geology

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ATE OF CALIFORNIA—RESOURCES AGENCY
EDMUND G. BROWN, Governor
EPARTMENT OF CONSERVATION
CRAMENTO

December 28, 1966

HON. HUGO FISHER, ADMINISTRATOR
The Resources Agency of California
Sacramento, California

Sir:

I have the honor to submit to you for transmittal to Governor Edmund G. Brown the 59th Report of the State Geologist, Chief, Division of Mines and Geology, describing activities of the Division for the triennium July 1, 1963, to June 30, 1966.

Respectfully submitted,

Ian Campbell

Ian Campbell, Director
Department of Conservation

Resources Building
Sacramento

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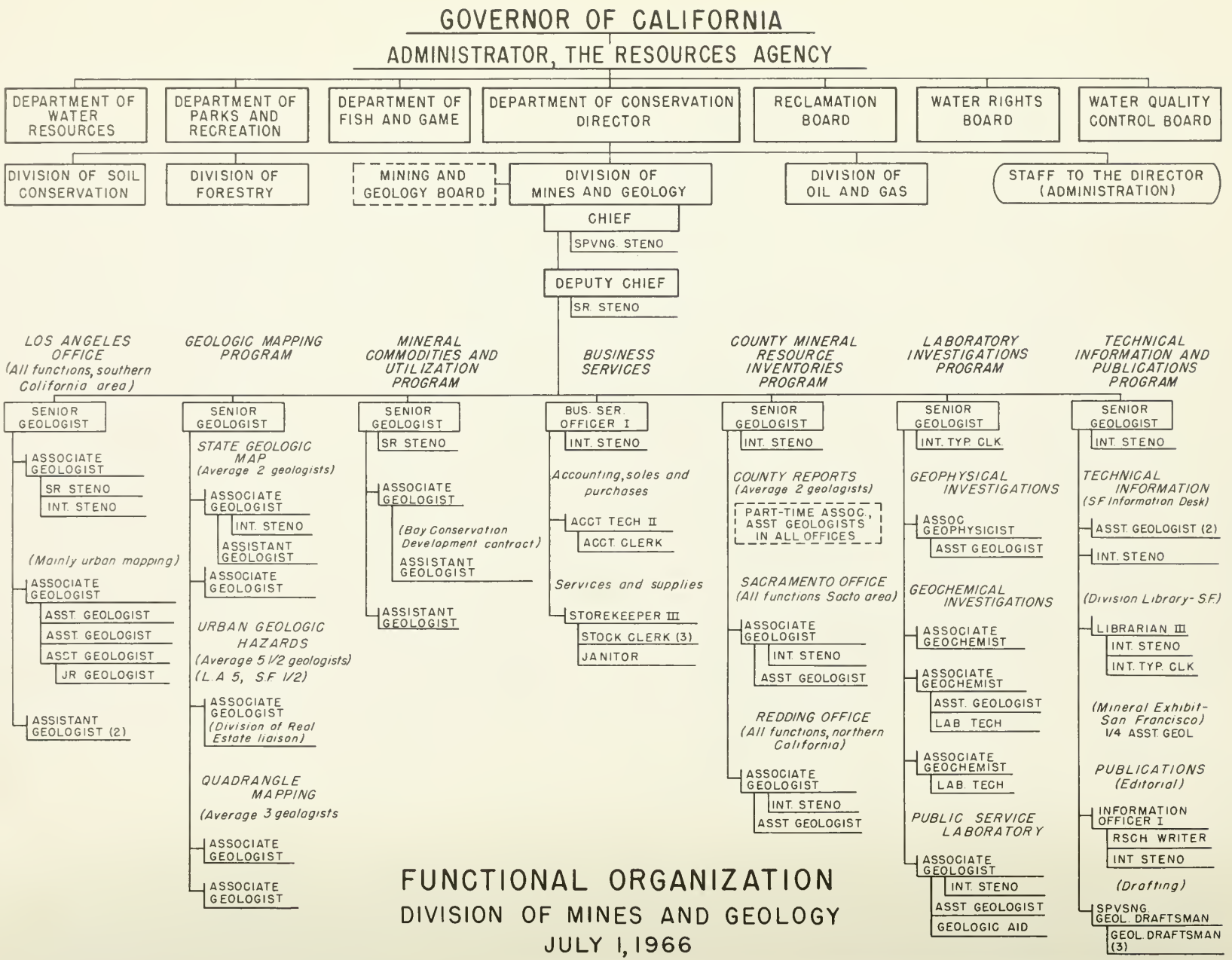


FUNCTIONAL ORGANIZATION
DIVISION OF MINES AND GEOLOGY
JULY 1, 1966

FUNCTION AND PROGRAM OF THE DIVISION OF MINES AND GEOLOGY

The Division of Mines and Geology, one of four operating divisions of the Department of Conservation, The Resources Agency, gathers information about the geology of California and the mining industry and makes this information available for the benefit of the State and to further the discovery and use of its mineral resources. It serves as the Geological Survey of California, concerned with all aspects of the earth sciences in the state.

The Division's objectives are divided among four main data-gathering programs--Geologic Mapping, Mineral Commodities and Utilization, County Mineral Resource Inventories, and Geophysical and Geochemical Investigations--and two main data-distributing programs--Publications and Technical Information. In order to accomplish these objectives, the Division employs a staff of a Civil Service chief and a deputy chief, 34 geologists, 3 geochemists, and 1 geophysicist plus 33 supporting technical, editorial, and clerical personnel. Besides Division headquarters in the Ferry Building, San Francisco, there are eleven people in Los Angeles and three people each in Sacramento and in Redding.

The State Mining and Geology Board, consisting of five members appointed by the Governor for four-year staggered terms, advises the Division on matters of policy.

The following is a summary of the Sections of the Public Resources Code (1965 Statutes) under which the Division operates.

Section	Substance of Law
601, 607	Establishes Department of Conservation in The Resources Agency, and Division of Mines and Geology.
660-667	Establishes State Mining and Geology Board.
680	Establishes State Geologist as Chief of Division.
2201	State Geologist shall employ geologists to do Division's work.

2202 State Geologist shall maintain offices, museum, library, and laboratory in San Francisco.

2203 State Geologist shall submit annual report.

2204 State Geologist may receive and manage gifts on behalf of State.

2205 To promote the mining industry, State Geologist may:

Study mineral resources, mineral industries, and geology of the State.

Collect mineral statistics.

Collect geological and mineralogical specimens and models to constitute Division's exhibits.

Provide technical library to be Division's library.

Maintain, in effect, a bureau of information on the State's mineral industries.

Conduct studies of geologic hazards in urban areas, including cooperative programs.

Maintain a laboratory to perform physical and chemical tests and analyses.

Issue bulletins on statistics and technology of the State's mineral industries.

2207 State Geologist shall receive annually reports showing production of every mine in California and keep these reports confidential. These production statistics shall be compiled to show value of each reportable mineral produced in each county and be published annually by June 30.

2208	State Geologist and his staff may enter or examine all mines in California to gather data.
2209	State Geologist may fix prices and sell Division publications and may furnish free copies to libraries.
2250-2275	State Geologist shall manage licensing of gold and silver buyers and administer their activities under these regulations.

State Mining and Geology Board

This Board consists of five members appointed by the Governor, with the advice and consent of the Senate, for terms of four years without compensation. They shall be associated with, or have detailed knowledge of, the prospecting for, production, processing, or marketing of the minerals of the state.

The Public Resources Code, as amended by Senate Bill 703 in 1965, changed the name of the Board from State Mining Board to State Mining and Geology Board. The amended code now requires that "The board shall represent the state's interest in the development, utilization and conservation of the mineral resources of the state, and in the development, collection, collation, and dissemination of geological information necessary to the understanding and utilization of the state's terrain. It is empowered to establish policies conforming to the provisions of State statutes to govern the administration of the Division of Mines and Geology."

Close liaison is maintained between the Division and the Board through the Board's chairman and through review of Division programs and activities at the Board's meetings. The Board has played an important role in the relationship between the Division and Federal agencies involved in the administration of public lands. It is significant that the Division's first efforts at detailed geologic mapping to delineate possible geologic hazards were encouraged by the Board even before the Code was modified (as previously quoted) to reflect the Division's obligation to do such work.

Meetings 1963-64

September 15, 1963		Los Angeles
November 5, 1963		Sacramento
November 15, 1963	(committee only)	San Francisco
January 17, 1964		San Francisco
April 9, 1964		Los Angeles

Meetings 1964-65

November 6, 1964		Los Angeles
December 7, 1964	(informal)	San Francisco
May 27, 1965		Los Angeles

Meetings 1965-66

December 2, 1965	San Francisco
February 3, 1966	Los Angeles
March 17, 1966	San Diego

Mining and Geology Board Members
as of July 1, 1966

Name and Affiliation	First Appointment	Current Appointment Effective January 15	Term Ends January 15
Philip R. Bradley Consulting Mining Engineer 2801 Oak Knoll Terrace Berkeley 94705	1943	1964	1968
Edmond F. Brovelli President, Basalt Rock Company, Inc. Post Office Box 734 Napa	February, 1962	1963	1967
*Richard H. Jahns Dean, School of Earth Sciences Stanford University Stanford 94305 (2312 Branner Drive Menlo Park 94026)	February 10, 1966	1966 (February 10)	1970
D. Loring Marlett Vice President, Great Lakes Carbon Corp. 630 Shatto Place Los Angeles 90005	September 28, 1960	1964	1968
T. Howard Rodgers Petroleum Engineer Vice President, Chanslor-Western Oil and Development Company 4549 Produce Plaza Los Angeles 90058	July 17, 1959	1963	1967

*Succeeded Lewis L. Huelsdonk, Consulting Mining Engineer (formerly Vice President, Best Mines), Box 177, Downieville

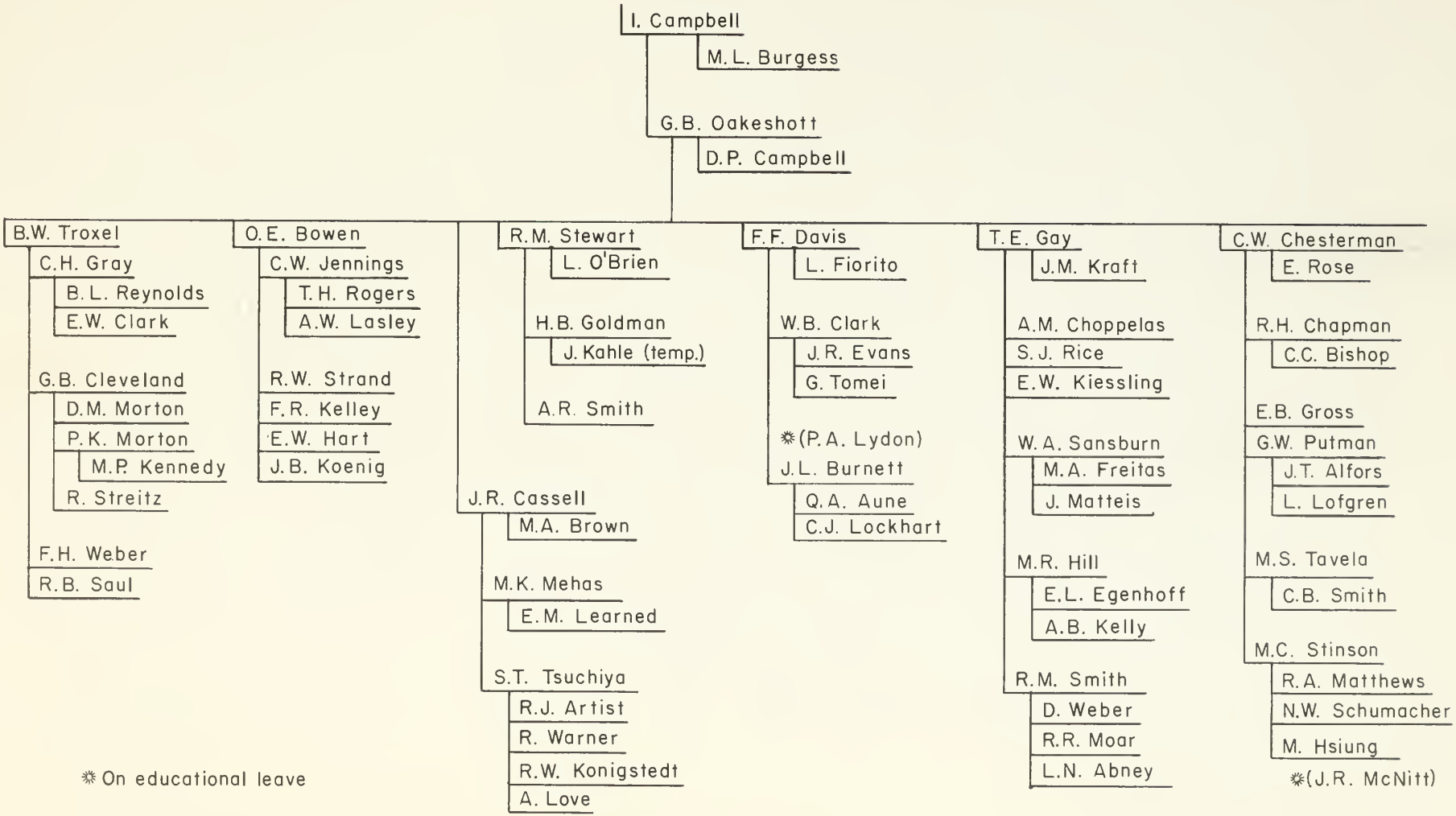
Table 1

Division of Mines and Geology
BUDGET SUMMARY
1963-64, 1964-65, 1965-66

Expense Category	1963-64 (actual)		1964-65 (actual)		1965-66 (estimated)
Personal Services		651,151		693,094	743,622
Operating Expenses					
General Expense	13,233		13,674	14,762	
Printing	79,563		86,734	97,000	
Communications	25,054		23,760	26,151	
Travel-in-State	20,618		19,776	22,700	
Motor Vehicle Operations	9,690		12,100	12,540	
Rent--Land and Buildings	120,575		129,351	132,896	
Professional Services (includes cooperative programs with U.S. Bureau of Mines and University of California)	37,500		38,000	28,000	
Purchase Technical Reports	2,200		1,400	2,200	
Repair and Maintenance	1,268		1,811	1,500	
Exhibits	150		156	200	
Blueprinting and Photography	4,612		4,250	5,000	
Library Services	1,271		1,303	1,900	
In-Service Training	212		495	495	
Laboratory	3,761	319,707	2,816	335,626	3,500	348,844
Equipment		17,833		30,774	21,870
State Geologic Map		18,944		17,827	17,161
Cooperative Program with U.S. Geological Survey		30,000		30,000	30,000
Reimbursements		-72,906		-67,602	-28,000
TOTAL EXPENDITURE		964,729		1,039,719	1,133,497

PERSONNEL AND REPORTING RELATIONSHIPS

July 1, 1966



* On educational leave

ADMINISTRATION

Budget

Stringent State policy for fiscal austerity held the Division's budget essentially at previous-year levels from 1963-64 through 1965-66 except for minor "cost-of-living" increases.

State government has been moving since 1963 into a program budget system. In 1966, systems were being developed to separate Division costs by programs and to keep detailed time-accounting records on individual projects.

Personnel

Four new geological positions were filled during the triennium, principally to implement cooperative programs on geologic hazards and urban geology with the County of Los Angeles and the City of San Diego. One temporary geologist was hired for the cooperative program with the Bay Conservation Development Commission on San Francisco Bay.

Geologists Philip A. Lydon and James B. Koenig were on educational leave about two years each during that period, completing Ph.D. requirements at the Universities of Oregon and Nevada, respectively. Geologist James R. McNitt was on two-year intergovernmental loan to the United Nations, New York, as a staff specialist in geothermal power resources. Starting in June, 1966, as many as seven university students were hired, using matching funds under the Federal Higher Education Facilities Act, to assist with library, editorial, mineral exhibits, laboratory, map room, and geophysics projects.

Under the encouragement of the Administrator of Resources and the Director of Conservation, with Department staff assistance, the Division started in 1965 to plan a major reorientation of Division objectives and staff effort and a proposed Division reorganization. The purpose of these studies, and of the partial shift of work emphasis under administrative authority, is to enable the Division to make timely progress toward a major state role in coping with the emerging concept of geologic hazards; to increase the availability of geologic information; and to play a more active role in such growing fields as river basin planning and development of marine resources.

Program

Two statewide conferences on geologic hazards, sponsored by The Resources Agency, but planned and conducted jointly by the Department of Water Resources and the Division of Mines and Geology, focused on the increasing need for State concern with geologic hazards. The first conference, December 1964, in San Francisco, emphasized hazards due to earthquakes and faulting; the second, May 1965, in Los Angeles, emphasized landslides and subsidence. Two advisory committees of prominent earth scientists, appointed early in 1965 to recommend on the State's proper responsibilities in this critical field and the best organizational patterns, had not completed their reports by July 1, 1966.

Administratively, the Division increased its emphasis on geologic hazards work during the triennium by adding urban (large-scale) geologic mapping projects in Contra Costa, Los Angeles-Ventura, Marin, and Orange Counties; by starting a cooperatively funded large-scale hazards-mapping and mineral resources project with the City of San Diego; by a series of informative articles on geologic hazards in Mineral Information Service; by participation on advisory hazards-evaluating committees; by advising various local jurisdictions on possible geologic dangers and what actions to take; by establishing a continuous hazard-advisory liaison with the California Division of Real Estate; and by increasing the training of staff geologists in the specialty of engineering geology. The cooperative geologic mapping project with the Los Angeles County Flood Control District and the Los Angeles County Engineer continued through the triennium.

In May, 1966, the San Francisco Bay Conservation and Development Commission contracted for Division geologists to supply data on the geology of the Bay as background for other studies by the Commission.

In January, 1964, the Senate Permanent Fact-Finding Committee on Natural Resources held hearings in San Francisco under Senate Resolution 190 (1963) to recommend measures "to improve and expedite the development of the geologic and mineral knowledge of the state and make such knowledge widely and promptly available to help meet the growth demands confronting the State of California." The Committee's report, "The Geologic Needs of California," recommended in essence that the Division of Mines and Geology perform as the Geological Survey of California; namely, discharge the State's responsibilities

for identification, collation, and dissemination of all geologic data--especially to emphasize the adequate mapping of geologic hazards and the location and identification of economic mineral commodities. The Committee recommended centralization of these responsibilities in the Division to provide for the geologic information needs of all other State agencies and other jurisdictions in California. The report also proposed a three-step augmentation to the Division's budget totaling $678,000 to enable this.

Senate Bill 703 (1965) defined and provided for some expansion of the Division's functions--particularly enabling cooperative programs for large-scale geologic mapping to provide timely delineation of geologic hazards in urban areas--but no additional funds were provided to accomplish the desired results.

In early 1966, the Legislative Analyst's analysis of the 1966-67 budget bill recommended expediting a program "for the shifting of basic earthquake and geologic hazards work to the Division of Mines and Geology" from the Department of Water Resources and the seeking of funds in the 1967-68 budget for the Division to perform that work. Discussions with the Department of Water Resources in 1965 and 1966 have explored the proper separation of geologic functions between the two agencies to place basic studies with the Division and retain geologic work needed to support the engineering of water projects with the Department.

The Future: Directions and Needs

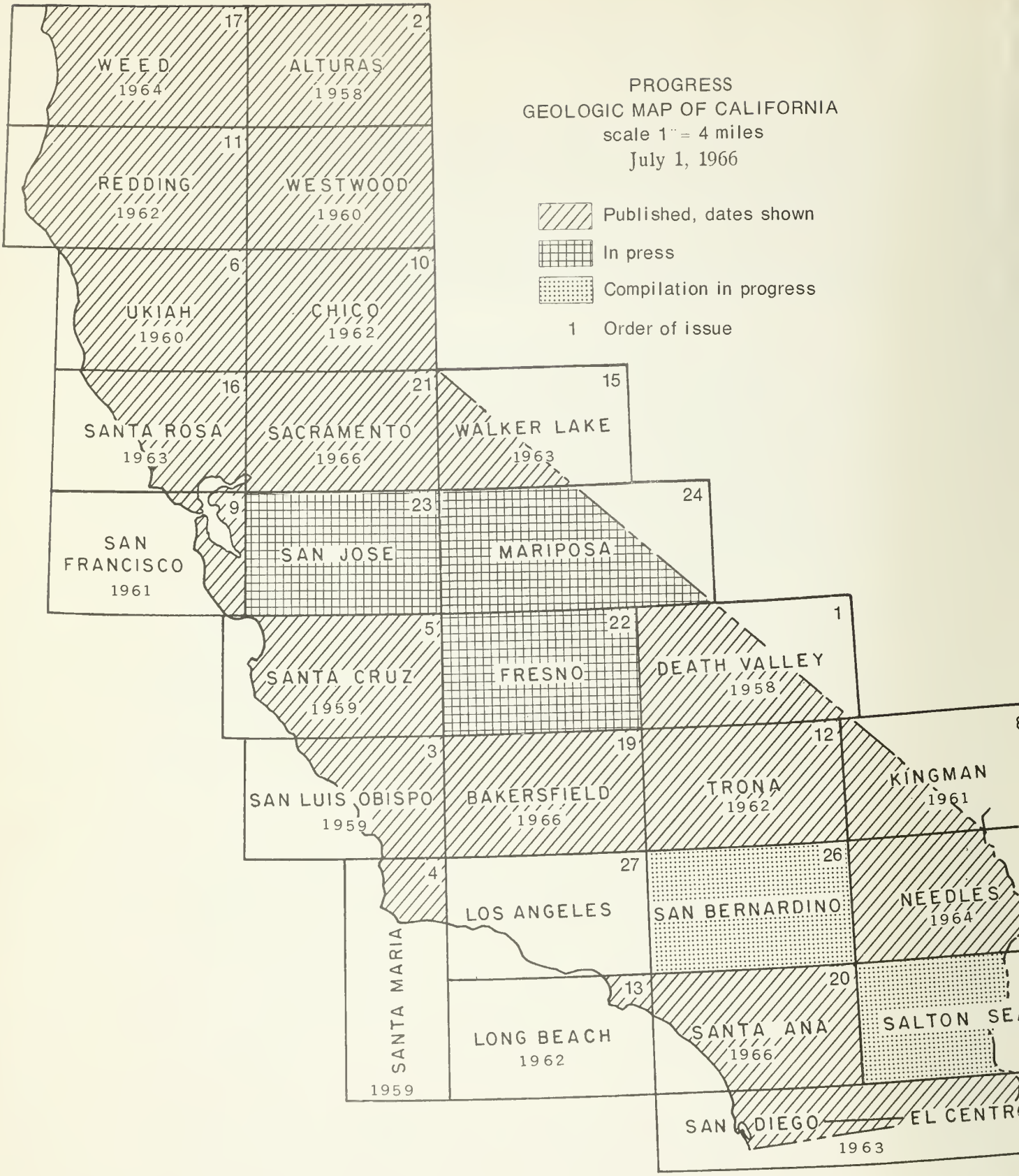
Resolution of the Division's enlarged future role as the Geological Survey of California is needed, as well as budget support of steps required to implement that role. Division management's planning in 1965-66 of reorientation of Division objectives (pursuant to various administrative, legislative, and public orders and suggestions) and staff reorganization patterns needed to achieve those objectives await the recommendations of the geologic hazards advisory committees, resolution of interaction with Department of Water Resources, and control agency approval before the needed changes can be effected.

Division effectiveness in the important field of marine resources, emerging as a primary Division responsibility in the next decade, will require addition of at least one marine geologist position as soon as possible and the addition of specialized equipment and staff. To advance in the needed direction of analysis of future needs of California's minerals

industry requires addition of a trained mineral economist staff position. The need to support basic geologic studies, including quadrangle and geologic hazards mapping projects, with adequate determinations of geologic age and stratigraphic sequence of rock units requires addition of at least one paleontologist to the staff. In-service and specialized training of present staff in these disciplines and cooperative help from other agencies is underway, but these are at best stop-gap substitutions for the proficiencies required.

Increases in both the number and the importance of requests by other agencies, State and local, for geologic data from the Division consume manpower already in short supply. Beyond the many needs for geologic hazards data, such activities as Division of Real Estate liaison, river basin planning, educational data on State parks, and earth science and conservation education consultation are examples of Division service needed by other agencies. Better geologic service to the many public agencies that have demonstrated a real need for it requires staff assignments to such projects beyond the Division's present manpower.

Lastly, recognition is needed of the steadily increasing level of management effort required of the Division staff during 1963-66 and for the foreseeable future. Institution of a quarterly progress reporting system, increased numbers of reports required at Department and Agency levels, and institution of time-reporting and effective program budgeting systems all require significant increase in management effort, which has been gradually subtracted from the effort available for direct program management and technical accomplishments.


PROGRESS
GEOLOGIC MAP OF CALIFORNIA
scale 1" = 4 miles
July 1, 1966
Published, dates shown
In press
Compilation in progress
1 Order of issue
17
WEED
1964
2
ALTURAS
1958
11
REDDING
1962
WESTWOOD
1960
6
UKIAH
1960
10
CHICO
1962
16
SANTA ROSA
1963
21
SACRAMENTO
1966
15
WALKER LAKE
1963
9
SAN
FRANCISCO
1961
23
SAN JOSE
MARIPOSA
24
1
5
SANTA CRUZ
1959
22
FRESNO
DEATH VALLEY
1958
3
SAN LUIS OBISPO
1959
19
BAKERSFIELD
1966
12
TRONA
1962
KINGMAN
1961
4
SANTA MARIA
1959
27
LOS ANGELES
26
SAN BERNARDINO
NEEDLES
1964
13
LONG BEACH
1962
20
SANTA ANA
1966
SALTON SE
SAN DIEGO
1963
EL CENTR

GEOLOGIC MAPPING PROGRAM

Geologic maps show the kinds and ages of the rocks that lie on or close to the earth's surface and the structures found in them. Consequently, geologic maps indicate the kind of setting or environment in which useful and potentially useful mineral deposits may occur; and they point up places where geologic hazards, like landslides, exist and where earthquakes may be centered. Small-scale geologic maps (those with a scale of 4 miles or more per inch) are useful to various public and private agencies for planning and demonstration purposes. Equally important are larger scale (1 mile or less to the inch) geologic maps of the same areas, showing rock types and structures in much greater detail and precision, for operational use by engineers and others who wish to build structures on the earth's surface or to remove mineral materials from the ground.

This program has three main activities or subdivisions:

1. GEOLOGIC MAP OF CALIFORNIA (small scale, 4 miles per inch)

Accomplishments in 1963-64

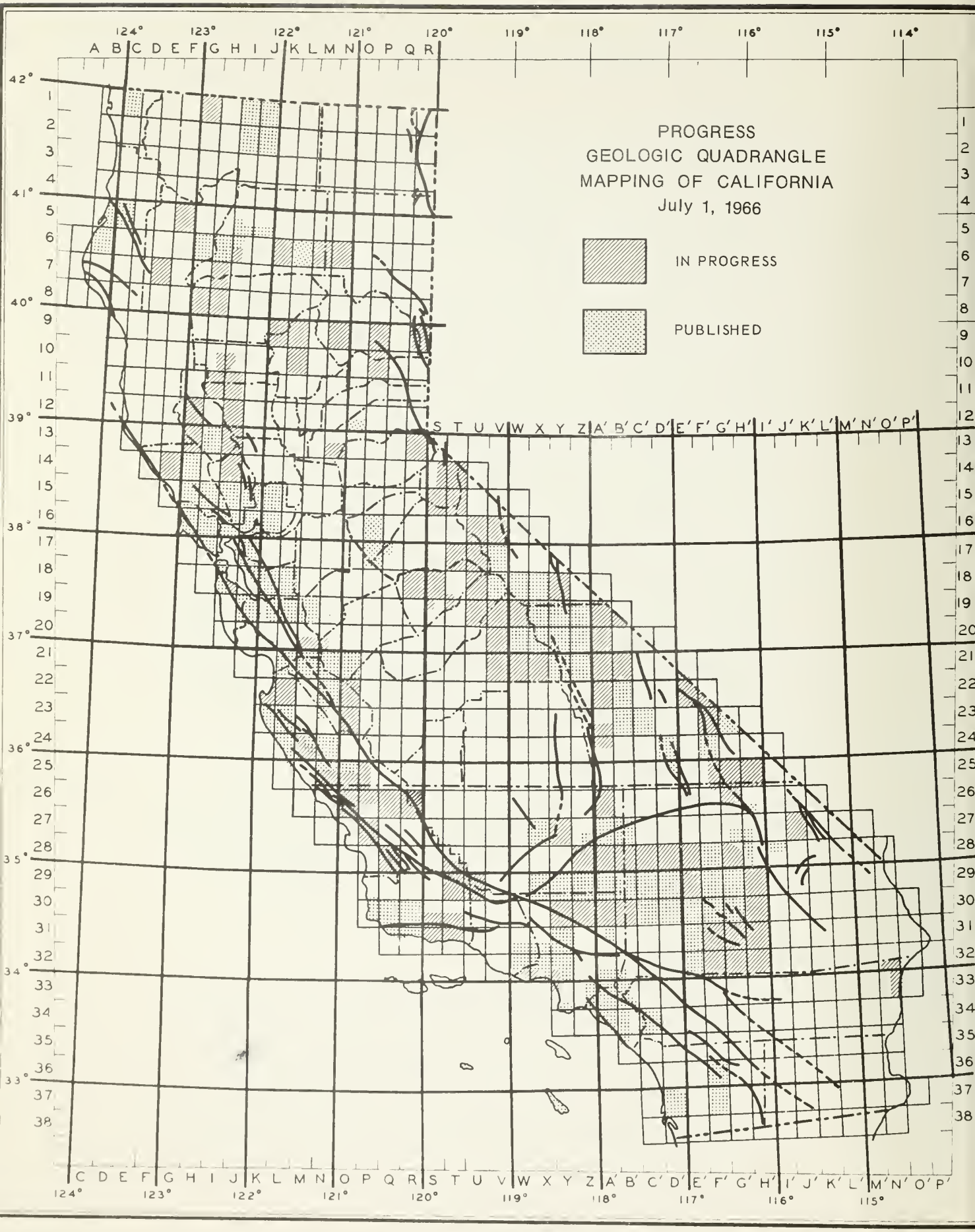
During 1963-64, the Santa Rosa, Weed, San Diego-El Centro, Long Beach, and Walker Lake sheets were released, completing 17 of the 27 sheets scheduled to cover the entire state. .Needles sheet was in press on July 1, 1964; and six of the remaining nine sheets were in process of compilation.

Accomplishments in 1964-65

During 1964-65, the Needles sheet was released, completing 18 of the 27 sheets to cover the state. The Bakersfield, Santa Ana, and Sacramento sheets had been submitted for publication during the year; and four of the remaining six sheets were in process of compilation.

Accomplishments in 1965-66

During 1965-66, the Bakersfield, Santa Ana, and Sacramento sheets were issued, completing 21 of the 27 sheets scheduled to cover the entire state by 1968. On July 1, 1966, the Fresno sheet was in press; the Mariposa and Salton Sea sheets were nearly ready to go to press; and the San Bernardino sheet was being compiled. The last sheet of the series, the Los Angeles sheet, has been assigned and will be completed during 1967-68.


PROGRESS
GEOLOGIC QUADRANGLE
MAPPING OF CALIFORNIA
July 1, 1966
IN PROGRESS
PUBLISHED

2. QUADRANGLE MAPS. The objective is complete coverage of California with lithographed intermediate-scale maps at a scale of 1 mile to the inch or, in some selected areas, 1/2 mile to the inch. This type of map is drawn and published on standard U. S. Geological Survey topographic quadrangles and is widely used by geologists, engineers, and others, including those at all levels of public agencies as well as private businesses. Division staff members prepare some of these, whereas others are prepared by cooperating agencies and individuals.

Accomplishments in 1963-64

During 1963-64, twelve of the 24 quadrangle mapping projects assigned to Division geologists were active. Monterey and Matterhorn Peak quadrangles (in Monterey and Inyo Counties, respectively) neared completion; and NE 1/4 Shoshone quadrangle, Inyo County, was finished for publication. The Division published a map and report on Panamint Buttes quadrangle, Inyo County; another, Oroville quadrangle, Butte County, adjacent to Oroville Dam, was in press.

Accomplishments in 1964-65

During 1964-65, 23 of the 28 quadrangle mapping projects assigned to Division geologists were active to some extent. The Division published the Mt. Boardman (Stanislaus County) quadrangle geologic map sheet and had two reports (Oroville quadrangle, Butte County, and the Redding 7 1/2 quadrangle, Shasta County) in press at the close of the year.

Accomplishments in 1965-66

During 1965-66, the French Gulch, Goleta, E 1/2 Mt. Hamilton, N 1/2 Old Dad Mountain, Oroville, and San Rafael 15-minute quadrangles were issued, plus the Carpinteria, Hildreth Peak, Little Pine Mountain, Redding and Santa Barbara 7 1/2-minute quadrangles. Progress was made on 17 of the 24 quadrangles being prepared by Division staff members. Four 15-minute quadrangles (Kelseyville and Lakeport by a Division geologist and Fremont Peak and Opal Mountain quadrangles by an outside author) were in press July 1, 1966.

Geologic Mapping Projects Active during 1965-66

A. Fifteen-minute quadrangles

1. Avawatz Mountains area (parts of Avawatz Pass, Baker, Leach Lake, Red Pass Lake, and Silurian Hills 15-minute

quadrangles) (R. H. Jahns, L. A. Wright, and B. W. Troxel) Mapping was about 90 percent complete for ultimate map sheet release.

2. Bodie (C. W. Chesterman and C. H. Gray, Jr.) Field work was about 50 percent complete at year's end. Part of this work is scheduled as a contribution to the Geological Society of America's Howel Williams memorial volume and part as a bulletin.

3. Coulterville and El Portal (O. E. Bowen and J. R. Evans) Mapping was roughly 75 percent complete for ultimate bulletin presentation.

4. Chilcoot (M. C. Stinson) Mapping was complete, and manuscript writing was in progress for map sheet release.

5. Funeral Mountains area (parts of Chloride Cliff and Big Dune 15-minute quadrangles) (L. A. Wright and B. W. Troxel) Mapping was about 60 percent complete for ultimate map sheet release.

6. Haiwee Reservoir-Keeler (M. C. Stinson) Mapping was about 50 percent complete for bulletin release.

7. Matterhorn Peak (C. W. Chesterman) Mapping was complete, and the manuscript was about 65 percent complete for bulletin release.

8. Monterey and Salinas (O. E. Bowen) Mapping was almost complete, and the manuscript was 50 percent finished for bulletin publication.

9. Panoche Valley (J. T. Alfors) Mapping was about 25 percent complete for bulletin publication.

10. Paradise (J. L. Burnett) Mapping was about 50 percent complete for ultimate map sheet publication.

11. Patterson Mountain (R. A. Matthews) Mapping was about 12 percent complete for ultimate bulletin release.

12. Richardson Springs (J. L. Burnett) Completed and in process of review.

13. San Luis Obispo (E. W. Hart) Mapping was 15 to 20 percent complete for ultimate bulletin presentation.

14. St. Helena (J. Koenig and N. L. Taliaferro) Mapping was completed, and manuscript was more than 95 percent complete for map sheet release.

15. Slate Range (parts of Manly Peak, Searles Lake, Trona, and Wingate Pass 15-minute quadrangles) (G. I. Smith, B. W. Troxel, C. H. Gray, Jr., R. E. von Huene) Report and map were completed and are being processed for publication as special report.

16. Yolla Bolly (Q. A. Aune) Mapping was about 10 percent complete for probable bulletin release.

B. Seven-and-one-half-minute quadrangles

1. NE 1/4 Avawatz Pass 15-minute quadrangle (B. W. Troxel) Mapping was nearly complete for ultimate map sheet release.

2. NW 1/4 Avawatz Pass 15-minute quadrangle (B. W. Troxel) About 50 percent complete for ultimate map sheet release.

3. NE 1/4 Confidence Hills 15-minute quadrangle (L. A. Wright and B. W. Troxel) Mapping was about 80 percent complete for ultimate map sheet release.

4. Corona North (C. H. Gray, Jr.) Mapping was about 20 percent complete for probable map sheet publication.

5. Hollister (T. H. Rogers) Mapping was about 10 percent complete for probable bulletin release.

6. Shadow Mountains (and north part of Shadow Mountains SE) (B. W. Troxel and J. N. Gundersen) Mapping was about 90 percent complete for bulletin release.

Special Projects:

1. Panoche Valley Metamorphic Rocks (J. T. Alfors) A mineralogical and environmental study; about 40 percent complete for probable special report.

2. Basement Rocks of Sequoia Park Area (J. L. Burnett and R. A. Matthews) Mapping was about 25 percent complete for probable special report.

3. Upper Cretaceous Stratigraphy of the Northern San Joaquin Valley (C. C. Bishop) Mapping and text work were nearly complete for special report.

3. GEOLOGIC HAZARDS MAPS. Detailed geologic maps at scales of 200, 400, 500, or 1,000 feet per inch are critically needed in densely populated areas where risks from geologic dangers such as landslides, poor foundation materials, or active faults (which may generate earthquakes) are known to be great.

Accomplishments in 1963-64

During 1963-64, a map of the Palos Verdes Hills area of Los Angeles County, mapped in cooperation with the County, reached final stages of completion for publication; a hand-colored copy was placed on open file. Maps of the SW 1/4 of the Glendora and SE 1/4 of the Azusa quadrangles in the San Gabriel Mountains, Los Angeles County, neared completion. A map and report on the San Clemente area, Orange and San Diego Counties, also was nearly finished.

Accomplishments in 1964-65

During 1964-65, maps of the SE quarter of the Azusa 7 1/2-minute quadrangle, SW 1/4 of the Glendora 7 1/2-minute quadrangle, and the Corral Canyon reactor site were completed and placed on open file where the public may use the work prior to its publication and general distribution. Work proceeded during the year on nine other projects that have been initiated in this part of the geologic mapping program.

Accomplishments in 1965-66

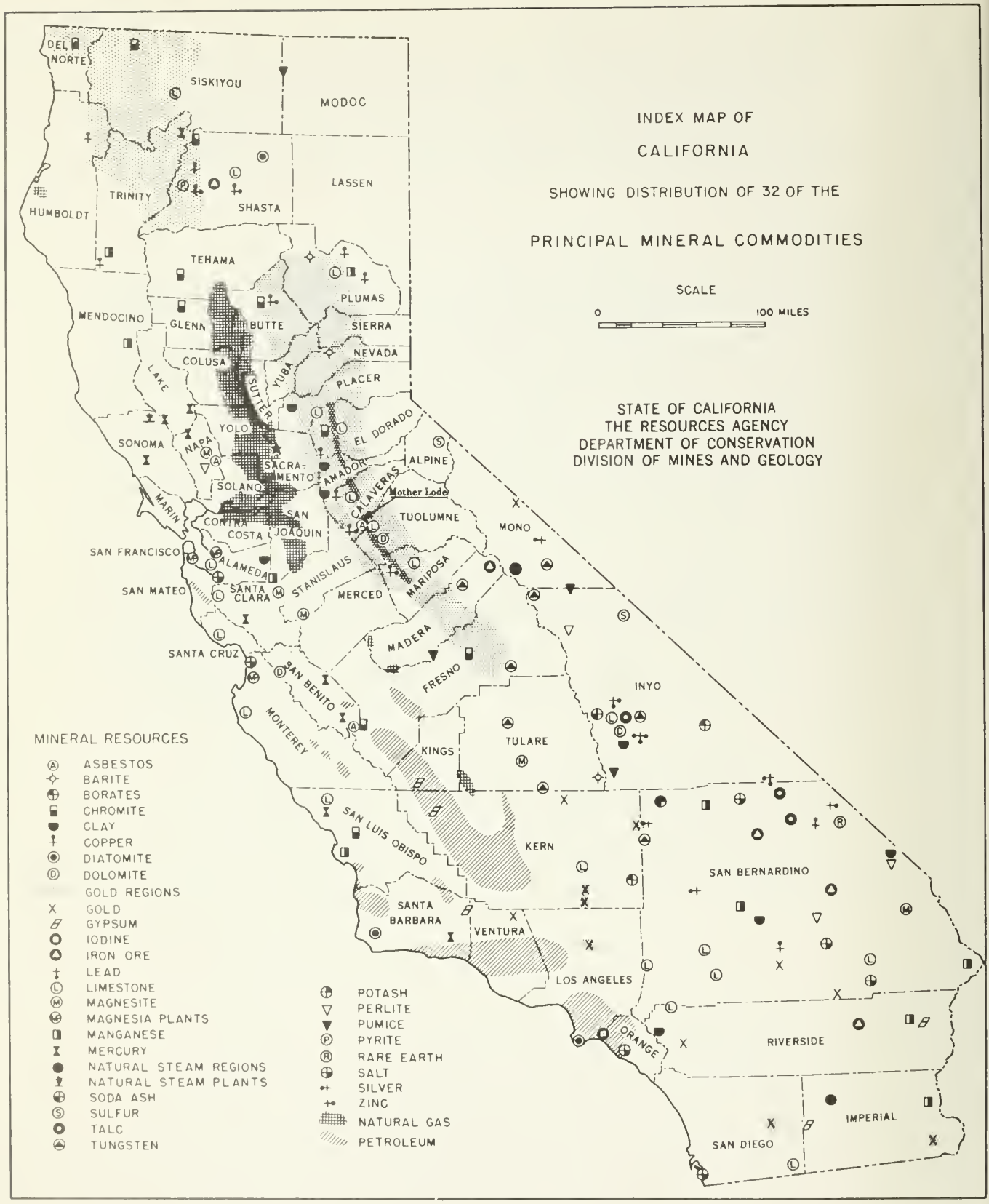
During 1965-66, two geologic hazards mapping projects were completed for publication and are awaiting processing. One is in the San Clemente vicinity of Orange and San Diego Counties. The other is in the NW 1/4 of the Walnut Creek quadrangle in Contra Costa County. A preliminary map of much of the city of San Diego, done in cooperation with the City, was nearing completion at the end of the fiscal year. Maps of the SW 1/4 of the Azusa 7 1/2-minute quadrangle and the SE 1/4 of the Glendora 7 1/2-minute quadrangle, both in Los Angeles County, were completed and placed on open file. The east central part of the

Mt. Wilson 7 1/2-minute quadrangle, Los Angeles County, was almost finished by year's end. Material progress was made on the Canada Gobernadora 7 1/2-minute quadrangle in Orange County, the Thousand Oaks and Oat Mountain 7 1/2-minute quadrangles in Los Angeles County, and the San Rafael 7 1/2-minute quadrangle in Marin County.

The Future: Directions and Needs

Completion of the 27-sheet State Geologic Map is progressing on schedule, and the project is highly successful. During 1965-66, five 15-minute quadrangles and five 7 1/2-minute quadrangles were issued to the public with supporting reports, one of the Division's most productive years to date. However, on the basis of stated goals to complete California coverage by 1985, this productivity is still 2 1/2 quadrangles short of the necessary minimum of 10 quadrangles a year. Five maps and reports involving areas of high probable geologic hazards were completed and two more were nearly completed.

The Division's greatest single need is for an Associate Paleontologist to support both quadrangle and geologic hazards mapping. We have been requesting an augmentation for this purpose every year for the past five years. We also badly need substantial augmentation in personnel, funds, and publication support for both the quadrangle and geologic hazards areas of the Geologic Mapping Program.


INDEX MAP OF
CALIFORNIA
SHOWING DISTRIBUTION OF 32 OF THE
PRINCIPAL MINERAL COMMODITIES
SCALE
0
100 MILES
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
COLUSA
NEVADA
LAKE
SUTTER
YUBA
PLACER
YOLO
EL DORADO
SONOMA
NAPA
SACRAMENTO
AMADOR
ALPINE
SOLANO
CALAVERAS
Mother Lode
MARIN
CONTRA COSTA
SAN JOAQUIN
TUOLUMNE
MONO
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA CLARA
MERCED
MADERA
SANTA CRUZ
FRESNO
INYO
SAN BENITO
MONTEREY
KINGS
TULARE
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
RIVERSIDE
IMPERIAL
SAN DIEGO
MINERAL RESOURCES
ASBESTOS
BARITE
BORATES
CHROMITE
CLAY
COPPER
DIATOMITE
DOLOMITE
GOLD REGIONS
GOLD
GYPSUM
IODINE
IRON ORE
LEAD
LIMESTONE
MAGNESITE
MAGNESIA PLANTS
MANGANESE
MERCURY
NATURAL STEAM REGIONS
NATURAL STEAM PLANTS
SODA ASH
SULFUR
TALC
TUNGSTEN
POTASH
PERLITE
PUMICE
PYRITE
RARE EARTH
SALT
SILVER
ZINC
NATURAL GAS
PETROLEUM

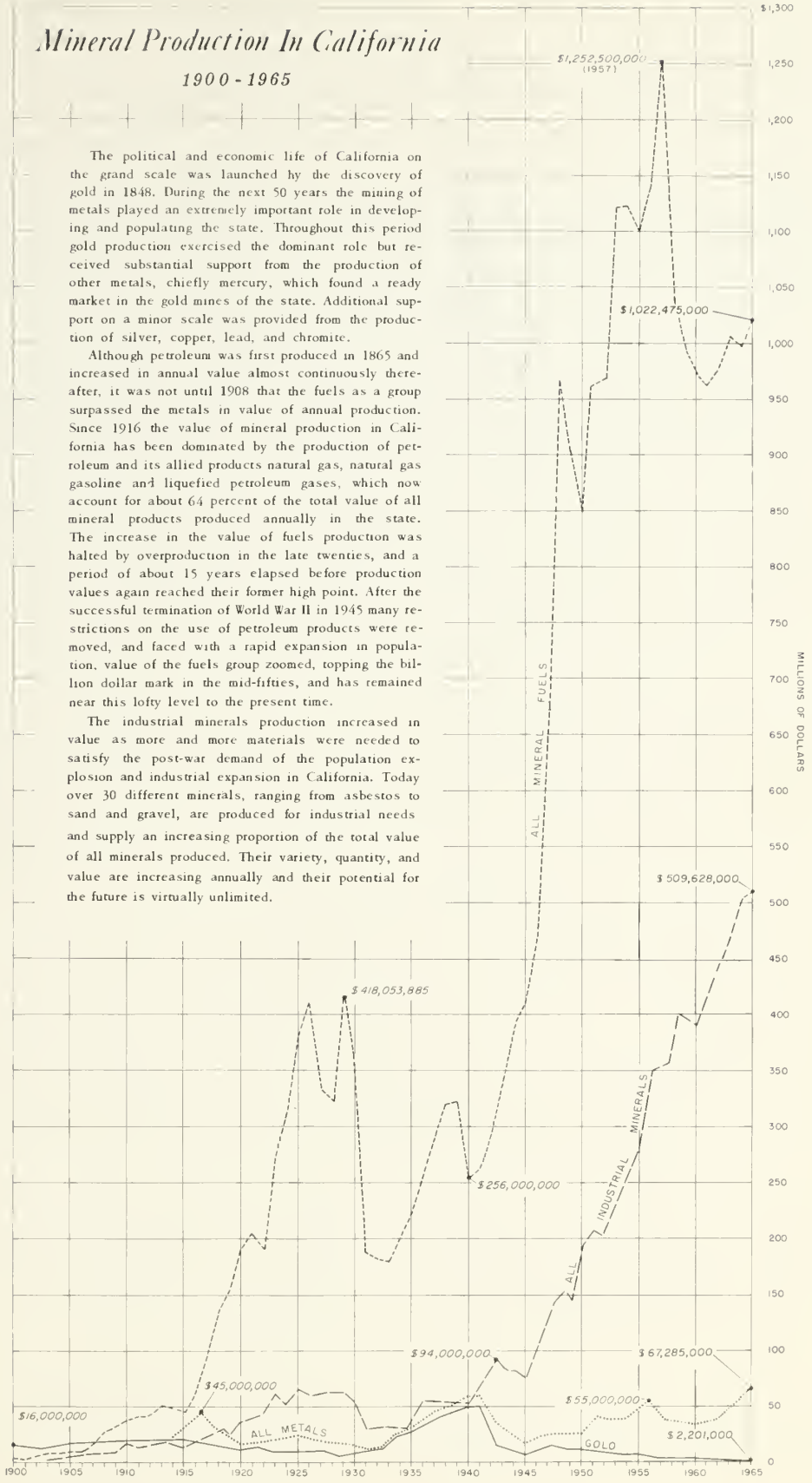
Mineral Production In California

1900 - 1965

The political and economic life of California on the grand scale was launched hy the discovery of gold in 1848. During the next 50 years the mining of metals played an extremely important role in developing and populating the state. Throughout this period gold production exercised the dominant role but received substantial support from the production of other metals, chiefly mercury, which found a ready market in the gold mines of the state. Additional support on a minor scale was provided from the production of silver, copper, lead, and chromite.

Although petroleum was first produced in 1865 and increased in annual value almost continuously thereafter, it was not until 1908 that the fuels as a group surpassed the metals in value of annual production. Since 1916 the value of mineral production in California has been dominated by the production of petroleum and its allied products natural gas, natural gas gasoline and liquefied petroleum gases, which now account for about 64 percent of the total value of all mineral products produced annually in the state. The increase in the value of fuels production was halted by overproduction in the late twenties, and a period of about 15 years elapsed before production values again reached their former high point. After the successful termination of World War II in 1945 many restrictions on the use of petroleum products were removed, and faced with a rapid expansion in population, value of the fuels group zoomed, topping the billion dollar mark in the mid-fifties, and has remained near this lofty level to the present time.

The industrial minerals production increased in value as more and more materials were needed to satisfy the post-war demand of the population explosion and industrial expansion in California. Today over 30 different minerals, ranging from asbestos to sand and gravel, are produced for industrial needs and supply an increasing proportion of the total value of all minerals produced. Their variety, quantity, and value are increasing annually and their potential for the future is virtually unlimited.



MINERAL COMMODITIES AND UTILIZATION PROGRAM

The function of this program is to conduct investigations of each of California's mineral commodities, from geological occurrence to economic development and utilization, and to make the resulting information available to the mineral industry and to the public. Activities include: comprehensive studies of significant commodities, on both a local and a statewide basis; maintenance of current information on all economic mineral commodities in California; publication of a comprehensive summary of the state's mineral resources at approximately ten-year intervals; compilation and publication of statistics on the state's mining industry; and studies of mineral utilization and economics.

During the interval 1963-64, the major emphasis by the Division was placed upon comprehensive statewide studies of sand and gravel; geothermal resources; limestone, dolomite, and cement; the gold districts of California; diatomaceous earth; pozzolanic materials; and barite. Economic geology projects were conducted on the clay and sand deposits of part of the Ione Formation in Stanislaus County; further studies of the clay deposits of the Castle Mountains, San Bernardino County; gypsite deposits in Kern County; geochemical and geological investigation of the Engel-Walker copper belt, Plumas County; geochemical investigations for lead, copper, and zinc in the Panamint Range, Inyo County; a geological, geochemical, and geophysical investigation of the Gorman tin district, Kern County; and the Dos Cabezas limestone deposit in San Diego County. For each of these commodity studies, Division geologists examine mineral utilization and marketing factors in addition to the geology of the deposits.

Accomplishments in 1963-64

During 1963-64, the value of intensive commodity investigations was demonstrated by a great expansion in California's asbestos producing industry--an industry established primarily because of several years of investigations by Division geologist Salem J. Rice. Production was reported in 1963 from five different deposits and was valued at more than $1.5 million, considerably larger than the total for all asbestos previously mined in California since the first recorded production in 1887. Since 1961, three large asbestos mills were put in operation in California with total capacity of 50,000 tons a year; another was under construction at the end of the year. Production value continued to rise to nearly $4.5 million in 1964 and a little over $6 million in 1965.

During May 1964, through the cooperative program with the U.S. Bureau of Mines, three diamond drill holes were drilled on the barite deposit on Girard Ridge, Shasta County. The cores provided subsurface information useful in the statewide study of barite.

Bulletin 180-B, Sand and Gravel in California, Part B, Central California, was published.

Accomplishments in 1964-65

Through the cooperative program with the U.S. Bureau of Mines, two diamond drill holes (totaling about 890 feet) were completed in the Gorman tin district to obtain subsurface information. Investigations continued into an apparent iron-tin relationship that may be of significance in prospecting for tin in other areas.

In addition to projects previously noted, staff time was directed to the preparation of portions of a report on the "Mineral and Water Resources of California," being assembled under the direction of the U.S. Geological Survey at the request of California Senator Thomas H. Kuchel.

Accomplishments in 1965-66

Work on the Kuchel volume, Part 1, "The Mineral Resources of California," was completed; and the results were submitted to Washington, D.C., for publication during 1966.

Manuscripts of two bulletins--Sand and Gravel in California, Part C, Southern California, and Gold Districts of California--were completed for final review and publication.

The Future: Directions and Needs

A distribution of staff effort in future years should provide at least for the current level of activity in this program. Minerals are one of the few new sources of wealth for California's expanding industrial and social economy. Information must continue to be made available in order to assure the continuing and orderly development of California's mineral resources.

Development of information on the mineral resources of the tide and submerged lands on the continental shelf will require an increased level of budgetary support for staff and operating expenses.

Efforts should be continued to achieve capability in the Division to conduct studies in mineral economics. The Division should utilize the science of economics in projecting economic forecasts involving mineral use, mineral needs, and minerals availability--all in the context of the state's various industrial and population growth factors.

Ore Buyers Inspection

The State Geologist, Chief of the Division of Mines and Geology,

under the Ore Buyers License Act of the Public Resources Code, issues annual licenses to any qualified person or association of persons purchasing for resale "...ores, concentrates, or amalgams bearing gold or silver, gold dust, gold or silver bullion, nuggets or specimens..." The Ore Buyers Inspector in the Sacramento office and the Assistant Inspector in the Los Angeles office check the records and activities of each licensee at least once a year for any violations under this Act.

Licenses are issued as either limited or unlimited, depending upon the value of the gold purchased during the year. A limited license allows the purchase of gold valued at less than $1,000; an unlimited license, gold valued at more than $1,000. These licenses are issued annually on a calendar-year basis.

During the triennium 1963-66, licenses were issued as follows:

License	Calendar Year		
	1963	1964	1965
Limited	42	42	33
Unlimited	21	40	37

PROGRESS
COUNTY MINERAL RESOURCE INVENTORIES PROGRAM
JULY 1, 1966
Published 1963-66
In progress
Published 1952-1962
15 or more yeors old
KERN New series,"County Reports" begon 1962
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
COLUSA
SUTTER
YUBA
NEVADA
LAKE
PLACER
YOLO
EL DORADO
NAPA
SONOMA
SACRAMENTO
AMADOR
ALPINE
SOLANO
CALAVERAS
MARIN
CONTRA COSTA
SAN JOAQUIN
TUOLUMNE
MONO
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA CLARA
MERCED
MADERA
SANTA CRUZ
FRESNO
SAN BENITO
INYO
MONTEREY
TULARE
KINGS
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL

COUNTY MINERAL RESOURCE INVENTORIES PROGRAM

A continuing objective of the Division of Mines and Geology is to gather and collate information on all the mineral deposits and mines in California and publish them on a county-by-county basis. These "County Reports," which collectively serve as an inventory of the state's mineral resources, are used by mine owners, consulting mining geologists, mining and oil companies, county and city planners, teachers, and others.

In the County Report, all known geologic and engineering data for each deposit are included, with complete references and location data and a map of the county showing regional geology and all deposit locations. Although the 58 counties range widely in number of deposits and time needed to report on them, the Division's goal is to revise and reissue County Reports so that none is older than fifteen years--an average rate of four County Reports to be published each year.

Accomplishments

During 1963-64, field work and writing were underway on reports for Alameda, Alpine, Imperial, Modoc, Placer, and Plumas Counties. Supervisors' review was in progress on reports for Monterey, Riverside, Shasta, and Sutter Counties. A report on Trinity County was in press. The Calaveras and the San Diego County reports were released for sale.

During 1964-65, field work continued on the reports for Alameda, Alpine, Imperial, Modoc, Placer, and Plumas Counties; and work was initiated on a Tehama County report. The reports on Shasta and Sutter Counties were transmitted to the publications program for final review and processing. The Trinity and Monterey County reports were in press.

In 1965-66, field work continued in Alameda, Alpine, Imperial, Modoc, Placer, Plumas, and Tehama Counties. The mineral location map was completed for Riverside County. The Sutter and Shasta County reports were approved for publication. The Monterey County report was in press, and the Trinity County report was released for sale.

The Future: Directions and Needs

The extensive and complete coverage given to mineral deposits in recent County Reports and their resultant bulkiness has made for burgeoning cost of publication, a high sales price, and somewhat restricted distribution. To help overcome these problems, a distinction was established in 1965 between projects for which the data will be assembled and published in the County Report series and those for which the data will be prepared for release as "open file data" in the Division's Geologic Information Center. Open file release will also permit the up-dating of each deposit report as new data come in; this has not been feasible for published County Reports.

The data on Sutter, Shasta, Riverside, Imperial, and Tehama Counties will be published as County Reports. The mineral resource information on deposits in Modoc and Alameda Counties will be prepared for use in the Geologic Information Center with little or no additional field work. The projects on Alpine, Placer, and Plumas Counties were still unconsigned to either classification on July 1, 1966.

LABORATORY INVESTIGATIONS PROGRAM

In 1962, programs of geochemical and geophysical studies were set up in the Division of Mines and Geology. Geochemists and geophysicists were hired to use the latest specialized equipment and techniques both in laboratory and field. The objective of these programs is two-fold: to accomplish special projects in these fields of specialty and to provide specialized data needed to support projects of Division geologists in other programs of the Division.

Accomplishments in 1963-64

Major geochemical research projects included a study of a body of granitic rock at Rocky Hill, Tulare County, to learn how the distribution of trace elements can be used to locate ore bodies of such base metals as copper, lead, and zinc; a study of tin mineralization in metamorphosed limestone beds in Kern County near Gorman; the mineralogy of deposits of the barium mineral sanbornite in eastern Fresno County; the unusual mineralogy of the impure Kalkar limestone deposit in Santa Cruz County; and many analyses of limestone samples from deposits throughout California as part of a new bulletin on limestone.

Geophysical research projects included the compilation of a map to show statewide distribution of gravity base stations on which future gravity surveys by all agencies and private firms can be based; completion of a magnetic survey of the Island Mountain copper deposit in Trinity County to locate hidden ore bodies; and a gravity survey of the ancient Ione basin, Amador County, in search of deeply buried possible sources of clay and lignite coal. Gravity studies were made to assist studies of geothermal power sources in Sonoma County and to investigate the depth of landslides in an engineering geology study of the Palos Verdes Hills area of Los Angeles County. A gravity anomaly map was made of the Sunnyvale area, Santa Clara County, in a cooperative project with the Department of Water Resources to study groundwater basins of the South San Francisco Bay area.

Accomplishments in 1964-65

Field and laboratory studies were continued on all geochemical investigations, including the Rocky Hill granite body in Tulare County; the Gorman tin deposits in Kern County; the barium deposits in eastern Fresno County; and the Kalkar limestone deposits in Santa Cruz County. Noteworthy publications of early results of several of these investigations include:

Putman, G.W., and Alfors, J.T., 1965, Depth of intrusion and age of the Rocky Hill stock, Tulare County, California: Bull. Geol. Soc. America, v. 76, p. 357-364.

Alfors, J.T., Stinson, M.C., Matthews, R.A., and Pabst, A., 1965, Seven new barium minerals from eastern Fresno County, California: Abst. American Mineralogist, v. 50, p. 314-340.

Gross, E.B., and Wainwright, J.E.N., 1965, Barium-tin-titanium silicate having benitoite structure: (Abst.) Geol. Soc. America Special Paper 82, p. 256.

A manuscript by Eugene B. Gross and Charles W. Chesterman on the mineralogy of the Kalkar limestone body was completed and submitted for Division publication. Many analyses of limestone samples were made for the statewide investigation of limestone deposits. A study of the aluminum minerals in the White Mountains, Mono County, was begun.

Geophysical research projects active in 1964-65 included the gathering of further data for the statewide gravity base stations network project and the gravity survey of the Ione basin. The gravity survey of the geothermal power area in Sonoma County was extended to assist in a regional geologic study of the Clear Lake basin in Lake and Sonoma Counties. A geophysical study was begun in the Port Wine area of Sierra County to ascertain the most applicable method of exploring for heavy metal-bearing gravels beneath a thick overburden of volcanic rock.

Manuscripts published included "Magnetic study of the Island Mountain mine area, Trinity County, California": California Division of Mines and Geology Special Report 86, by Rodger H. Chapman, and "California Division of Mines and Geology gravity program": Abst. Geol. Soc. Am. Special Paper 82, p. 265 (1965), by Rodger H. Chapman.

The cooperative gravity study of the South San Francisco Bay groundwater basins was completed, and a report and gravity anomaly map on the Sunnyvale area were submitted to the Department of Water Resources.

A project was started to compile a Bouguer gravity anomaly map of California, scale 1:250,000, to be published as an overprint on the sheets of the new Geologic Map of California. Such a gravity anomaly map will be useful for mineral exploration, future gravity and other geophysical studies, and in delineating the geologically hazardous areas in California.

Accomplishments in 1965-66

Field and laboratory research were continued on the geochemical projects which were initiated and under way in 1964-65. "Frequency distribution of minor metals in the Rocky Hill stock" by George W. Putman and John T. Alfors was completed and submitted for publication in Geochemica et Cosmochemica Acta. "Geochemistry and petrology of the Rocky Hill stock, Tulare County, California" by the same authors, which is the final report of this geochemical project, was approaching completion at the end of the year.

The report on the Kalkar limestone body in Santa Cruz County was in press in June, 1966; "Pabstite, the tin analogue of benitoite" by Eugene B. Gross, J.E.N. Wainwright, and B.W. Evans was published in American Mineralogist, v. 50, p. 1164-1169, 1965.

Geophysical research projects active in 1965-66 included the gathering of data for the Santa Cruz sheet of the Bouguer gravity anomaly map of California; the completion of field studies in the geophysical investigation of the Port Wine area, Sierra County; and the continuation of gravity studies in the Clear Lake basin in Lake and Sonoma Counties.

"Gravity base station network" by Rodger H. Chapman and Charles C. Bishop was published as California Division of Mines and Geology Special Report 90. Completed, but not published, was a gravity study of the site of the San Luis Reservoir, western Merced County, the result of a cooperative project with the U.S. Army Corps of Engineers. Also completed was a cooperative project with the State Division of Forestry to ascertain the configuration of the bedrock beneath an overburden of layered volcanic rocks in a search for a water supply for a tree farm near Magalia, Butte County.

The Future: Trends and Needs

The most critical problem for the Laboratory Investigations Program is to maintain front-rank effectiveness in the face of high costs and a low budget appropriation. The specialized activities of geochemistry and geophysics require sophisticated laboratory and field equipment whether projects are large or small. In these active disciplines, obsolescence is constant: Old equipment and methods are being modified and up-dated every year; and new equipment and techniques are being developed. A laboratory without means to stay current in its equipment rapidly slips from a forefront position to one of "also ran".

Modifications to the Division's X-ray and spectrographic equipment, needed but unavailable because of lack of funds, would save many man-hours' work and enable faster, more accurate, results. New tools, like laser equipment and the micro-probe (for analyzing extremely minute features of minerals and rocks with great accuracy), have become available in working models since the Division's laboratories were equipped but can't be obtained without funds.

Some of the elements of the study of earthquakes and the crustal strains that produce them require specialized, expensive equipment presently unavailable to the Division. A magnetic anomaly survey of California -- much needed and entirely feasible (as brought out at the 1964 hearings of the Senate Fact Finding Committee on Natural Resources) -- requires the use of long-available airborne magnetometer equipment still unobtainable by the Division. Studies of California's marine resources will require other forms of specialized, expensive equipment.

Lack of funds makes even the replacement of worn-out equipment a problem; worn equipment must be kept in use past its discard point by means of repairs that cost extra in money and staff time. Natural turn-over opportunities, to replace obsolete equipment with up-to-date models, are lost because of economy.

The other major area of need, for the Division laboratory program to maintain the needed level of effectiveness, is for technicians to perform the work. Even a well equipped laboratory cannot be effective without proper staff. The lack of qualified manpower, at both professional and supporting levels, has forced the recess of several on-going projects, retarded others, and delayed the initiation of many more.

TECHNICAL INFORMATION PROGRAM

The objective of the Technical Information Program is to inform California's public and its mining industry about all phases of geology and mining -- especially about the state's geologic setting, its geologic hazards, and its minerals industry -- and the results of work by Division and other earth scientists on these subjects. In short, the goal is to implement the Division's mission of serving as the Geological Survey of California.

The Technical Information Program acts to accomplish these objectives by providing, through a centralized information service function (Library, Information Desks at all four Division offices, Geologic Data Center, and Mineral Exhibit activities -- known collectively as "the Geologic Information Center"), both internal information services (to the staff) and external information services (to the public, to industry, and to government agencies at all levels).

Mineral Exhibits

The Division's collection of about 22,000 rock, ore, and mineral specimens and a few mine and mill models are in the San Francisco office. About 8,000 of these specimens are on display, most of them classified by Dana's system of mineralogy and others in representative collections from the 58 counties. The rest are in storage, available for technical study.

Library

The Division's technical library of some 25,000 books, about 250 periodicals, and nearly 2,000 maps is one of the most complete earth-science libraries in the West. It is used by the general public, as well as Division staff members. Each branch office maintains a small working collection, mostly for staff use. The library controls the distribution of about 1,300 copies of all Division publications to other libraries and technical institutions. The library also maintains the open file release system, whereby single copies of about a hundred complete and unpublished manuscripts are made available for noncirculating use of staff and the public, and the purchase of single copies at cost.

Geologic Data Center

Since 1964, the Division has been reorienting its efforts so as to anticipate and meet the state's rapidly enlarging need for geologic information.

The Geologic Data Center concept, for which staffing and equipment are still needed in July, 1966, represents a new move

toward a geologic information-storage-retrieval system designed as a step toward an eventual Automatic Data Processing application. The Geologic Data Center is to act as a bank of all available earth science data from sources inside and outside the Division, arranged in files by key subjects -- such as commodity, deposit name, and location -- for rapid retrieval and distribution whenever needed.

During 1965 and 1966, progressively greater emphasis has been placed by the Division on gathering and disseminating geologic information concerned with public safety, by minor changes in organization and operating patterns but within existing staff strength and classifications.

The Division's information services historically have been passive; that is, geared to responding to requests for information. Without diminishing that responsibility, the Division tried in 1965 and 1966 to move toward a more active role in generating and dispensing geologic information to those who need it, whether or nor they are aware of this need. The Division is working to emphasize the importance of geologic information to responsible officials, public and private, at all levels, in the decision-making process -- in the construction of buildings, power plants, schools, and airfields, as well as in developing mines.

The Future: Directions and Needs

Need in California for geologic knowledge -- and public recognition of that need -- grows more acute each year. The Technical Information Program needs further improvements to meet the growing demand for information service expected of the Division as the "Geological Survey of California". Acute needs are to:

1. Increase capability for geologic information and education functions through such programs as written materials -- articles, guidebooks, texts -- for school use in earth science and conservation topics; planning or producing films on these topics; and taking and distributing photographs.

2. Increase capability for reasonably prompt and complete service in earth science matters to other government agencies, at all levels, when needed and requested.

3. Complete long-delayed inventory and refurbishment of mineral exhibits in San Francisco by adding a curator position to the staff.

4. Further develop "geologic information center" concept of centralized collection, organization, and dispensing of earth science data -- of all types, from all sources -- in the San Francisco information desk area. Prepare to move from a manual to an automatic data processing (ADP) system of information storage and retrieval.

5. Until an ADP system is feasible, increase the use of Information Clerk positions to handle and dispense accumulated geologic data to free professional geologists from as much of this activity as possible so they can do needed technical and original projects.

6. Increase professional library staff to enable the library to catch up with the "geologic information explosion", which has doubled the output of geologic books and periodicals in the last decade.

7. Establish microfilm (microfiche) service and photocopy service at Information Desk and Library to dispense copies of needed data in written form rather than prepare personal answers to individual questions. Microfiche storage of technical periodicals in the library will allow up to 20 to 1 reduction of shelf space needed to store back copies, as well as permit inexpensive copies of needed excerpts.

8. Expand Division's information-providing capability beyond its traditional emphasis on mineral commodities and mining to the broadest possible coverage of the whole field of earth science, including "environmental" geologic mapping, engineering geology, and all the advancements in specialized earth-science fields such as geophysics and geochemistry.

9. Expand Division's capability for public information and public contact through mass media, such as press releases and television presentations.

10. Increase the earth science information-dispensing role of the Division's monthly release, Mineral Information Service, by increasing its staff and budget. This will allow broader and more thorough coverage of the wide span of earth science topics that California's people need to be informed about in interpretive terms aimed at the layman.

Technical Information Program

Accomplishments	1963-64	1964-65	1965-66
Answered telephone, letter, and personal inquiries (technical and nontechnical) at all four Division Information Desks.	29,000	33,000	28,000
Made technical contributions to professional geologic societies--technical talks, held offices, led field trips, etc.	90	49	28
Made semi-technical talks to schools, mineral societies, service groups, etc.	55	29	49
Distributed 35-specimen sets of important California minerals and rocks with descriptive booklet to California schools on request.	298	400	200
Distributed ten-book "conservation kits" of Division publications to California schools to aid conservation education, on request.	52	105	83
Identified rock and mineral specimens for California citizens and cooperating agencies (Public Service Laboratory).	2,189	*1,728	890

* $1 charge per specimen instituted April 1, 1965

PUBLICATIONS PROGRAM

Results of all Division work and selected work by outside geologists are published as Bulletins, Special Reports, County reports, Map Sheets, and monthly Mineral Information Service. Material published is technical data of immediate demand, basic scientific data, or technical material of broad interest written in less technical language. Division publications are widely distributed to libraries and other agencies and sold to individuals, including, but by no means limited to, geologists, miners, engineers, and consultants.

The objective of the Publications Program is to provide support to the Division's data-producing programs by performing technician functions to process written reports and maps generated by those programs for publication and to assure dissemination of the contained data as quickly, accurately, concisely, and attractively--yet economically--as possible.

The activities of the Publications Program include; a) reviewing all manuscripts for technical scope and accuracy; b) drafting maps and illustrations for lithography and printing; c) editing all manuscripts for clarity and conciseness of expression; d) preparing all manuscripts for printer and lithographer and expediting their progress through the printing process; and e) approving and announcing their release and advertising their availability. (Selection and priority of manuscripts to publish and over-all control over their contents are responsibilities of the data-producing programs in which each manuscript's subject matter lies.)

The effectiveness of the Publications Program's efforts is measured by the speed of processing and publishing manuscripts; the quality of final presentation of text and illustrations--their technical accuracy, clarity, conciseness, and professional appearance; and the economy of processing manuscripts, in reviewing, drafting, and editing manpower, and in printing and lithography costs. Prompt publication of the results of Division projects is essential to get data to the user while it is needed. Prompt publication also minimizes expenditures of project geologists' time in answering individual public requests for their results and in up-dating timely data within the report while it waits for publication.

Accomplishments in 1963-64

In 1963-64, these reports were released: County Reports 2, Calaveras County, and 3, San Diego County; Special Reports 72, Little Antelope Valley Clay Deposits, Mono County; 73, Panamint Butte Area, Inyo County; 75, Geothermal Power in California; 76,

Amboy Crater, San Bernardino County; 77, Ord Mountain District, San Bernardino County; 78, Montara Mountain Area, San Mateo County; 79, Xenotime in Music Valley Area, Riverside County; 80, Mount Diablo Area, Contra Costa County; 81, Lockwood Valley Area, Kern and Ventura Counties; 82, Short Contributions to California Geology, 1964; and Special Publication 33, A Description of the Set of Minerals and Rocks Furnished to California Schools.

During 1963-64, Mineral Information Service featured articles on Geology of Bodega Head, Sonoma County; Ground Water; California Asbestos Industry; Barite in California; Trona Sheet Area, San Bernardino County; Basin Placer Mining for gold; Geology of Placer Deposits; Stratigraphic Record of California; Glacier Trails of California; "A House that Minerals Made"; Unusual Phosphatic Rock in Trinity County; and Diving for Gold in 1849, besides many shorter items in each issue.

Also during 1963-64, several out-of-print publications in strong demand were reprinted: Bulletin 141, Geologic Guidebook along Highway 49--Sierran Gold Belt (The Mother Lode Country); Bulletin 158, Evolution of the California Landscape; The Elephant as They Saw It; Geologic Guide to Western Mojave Desert and Death Valley Region, from Bulletin 170.

Accomplishments in 1964-65

In 1964-65, these reports were released: Special Report 83, A geologic Reconnaissance in the Southwestern Mojave Desert. Bulletin 183, Franciscan and Related Rocks and Their Significance in the Geology of Western California. Map Sheet 3, Geology of the Mount Boardman Quadrangle. Bulletins 180-B, Sand and Gravel in California--Central California; and 173 Supplement 2, Minerals of California, 1958-1961.

During 1964-65, Mineral Information Service featured articles on the 1964 Alaskan Earthquake; University Projects on California Geology; Minerals for a Teeming World; Burney Falls; Geology of Space Exploration (3 parts); Depletion Allowance; New Minerals from Fresno County; Methods for Measuring Geologic Time; the Mineral Industry of California; Mecury; a series on geologic hazards; Tertiary Channels and Gold Deposits; Pt. Lobos; and Devil's Postpile, besides regular departments and other articles in each issue.

In addition, several out-of-print maps and issues of Mineral Information Service were reprinted in 1964, including List of Available Publications of the California Division of Mines and Geology.

Accomplishments in 1965-66

These publications were released in 1965-66: Map Sheets 4, Geology of the Redding Quadrangle, Shasta County; 5, Geology of the

Western Vallecitos Syncline, San Benito County; and 7, Geology of the Northern Part of the Old Dad Mountain Quadrangle, San Bernardino County; County Report 4, Mines and Mineral Resources of Trinity County; Bulletins 134, Part I, Chapter 3, Chromite Deposits of Shasta, Tehama, Trinity, and Humboldt Counties; 184, Geology of the Oroville Quadrangle, Butte County; and 185, Geology of the East Half of the Mount Hamilton Quadrangle, Santa Clara County; Special Reports 84, Stratigraphy, Structure, and Mineral Deposits in the Oro Grande Series near Victorville, San Bernardino County; 85, Economic Geology of the French Gulch Quadrangle, Shasta and Trinity Counties; 86, Short Contributions to California Geology, 1965; 87, Expansible Shale Resources of the San Jose-Gilroy Area, Santa Clara and Alameda Counties; 88, Queen of Sheba Lead Mine, Death Valley, Inyo County; 89, Deep-water Sedimentary Structures, Pliocene Pico Formation, Santa Paula Creek, Ventura Basin, Ventura County; and 90, The California Division of Mines and Geology Gravity Base Station Network; and 58th Report of the State Geologist, 1960-63.

During 1965-66, Mineral Information Service contained major articles on the Vaiont Dam disaster and a series of articles on geologic hazards due to earthquakes and landslides; the Wilderness Act; Inyo Craters and Mono Lake; Desert Pavement and "The Land of Little Rain"; landslide-caused giant wave at Lituya Bay, Alaska; the Eocene channel at French Meadows, Placer County; California Mineral Production statistics; Europium Oxide production at Mountain Pass; Oyster shell deposits of San Francisco Bay; Supersonic pile driving; Silver Mining at Old Calico; Clio and the Rockhound: the historian and geology; geothermal resources in California; and numerous short articles, reviews, news notes, and announcements.

The following out-of-print publications were reprinted in 1965-66: Legal Guide for California Prospectors and Miners; Special Report 75, Exploration and Development of Geothermal Power in California; Bulletin 154, Geologic Guide of the San Francisco Bay Counties; Bulletin 171, Earthquakes in Kern County in 1952; Bulletin 182, Geologic Guide to Merced Canyon and Yosemite Valley; and Bulletin 183, Franciscan and Related Rocks and Their Significance in the Geology of Western California.

As of July 1, 1966, the following manuscripts were in final stages of processing in the Division's editorial section or at the Office of the State Printer: Bulletin 186, Central Santa Ynez Mountains Area, Santa Barbara County; 187, Quartzite in California; 188 Opal Mountain and Fremont Peak Quadrangles, San Bernardino County; 189, Minerals of California; and 190, Geology of Northern California; Map Sheet 6, East Clark Mountain Area, San Bernardino County; 8, Palo Alto Quadrangle, Santa Clara and San Mateo Counties; 9, Kelseyville Quadrangle, Sonoma and Lake Counties; 10, Lakeport Quadrangle, Lake County; and 11, Geology of Western Marin County; County Report 5, Monterey County.

The Future: Directions and Needs

The following actions are needed as soon as possible to overcome long-established publication problems:

1. Process and publish without further delay the backlog of unpublished manuscripts--about 35 on July 1, 1966--delayed from publication, some as long as ten years, by shortages of drafting and editorial manpower and of printing funds. Delayed publication of new reports due to backlog hurts productivity in the other, data-producing, Division programs and deters completion of many worthwhile reports by off-staff authors.

2. Increase our capability to process and publish the steadily enlarging number of reports and maps that are being produced in the other, data-producing, Division programs. Established data-producing programs have been gradually enlarged, and new programs (like geophysical and geochemical investigations) have been added, without corresponding increase in capacity to publish their results.

3. Provide additional printing funds specifically for reprinting out-of-print publications of established strong public interest as a separate budget allocation, to save already inadequate printing funds for backlogged and new manuscripts.

4. Increase the release of intensely technical reports that have vital but limited need through means faster and less expensive than general publication and release. Open file release of master copies, with microfilm (microfiche) available for copies to be made at the expense of the few users who have the specialized need for such reports, is a hopeful future trend as new equipment and systems become available.

COOPERATIVE PROGRAMS

U.S. Bureau of Mines

The long-standing program of cooperation between the U.S. Bureau of Mines and the State Division of Mines and Geology in the gathering of mineral statistics from mine operators was continued. The two organizations also have in effect a cooperative agreement that provides for pooling information on mining properties and for publication of such data either separately or on a joint basis.

In late 1959, the Division initiated a cooperative program with the Bureau that provided, through a matching fund contract, for mutual support of selected research projects, whether undertaken by the Bureau or the Division. The Division's share was $35,000 in 1959-60 but was decreased to $30,000 for 1963-64 and 1964-65 and to $20,000 for 1965-66. The disposition of these funds is shown in Table 1.

The Bureau research projects that were supported under this contract were mostly metallurgical, as described in Table 2.

The balance of the Division's funds for this cooperative agreement provided support to various Division resource investigation projects which required subsurface data or specialized laboratory tests by the Bureau. The record of these resources investigations is shown in Table 3.

Table 2

DISPOSITION OF STATE FUNDS TO U.S. BUREAU OF MINES UNDER MATCHING FUND CONTRACT, 1959-66

Major Projects	Budget Years						
	1959-60	1960-61	1961-62	1962-63	1963-64	1964-65	1965-66
Metallurgical Research:							
Tungsten	25,000	20,000	15,000	Completed			
Chromite	Initiated 1961-62			9,000	10,000	(1) 10,000	All metallurgical work recessed (2)
Mineral Reconstitution	Initiated 1961-62		5,000			Recessed	See Table 3
Anorthosite	5,000	5,000	Completed				
Mining Research (slope stability, etc.)	5,000	5,000	5,000	1,000	Completed		
Resources Investigations	Initiated 1960-61	10,000	15,000	20,000	20,000	20,000	20,000
Total	35,000	40,000	40,000	30,000	30,000	30,000	20,000

(1) Expenditures during 1964-65 were almost wholly for chromium. Results from mineral reconstitution research were not encouraging.

(2) Chromium research was encouraging but had reached a point where continued support by the Division was not considered essential. Therefore, in order to conserve funds within the total allocation, the Division decreased by $10,000 the funds budgeted for this type of cooperative project.

Table 3

METALLURGICAL RESEARCH PROJECTS OF THE U.S. BUREAU OF MINES
SUPPORTED UNDER MATCHING FUND CONTRACT WITH DIVISION OF MINES AND GEOLOGY, 1959-1965

Project	Results
Production of high-purity tungsten and molybdenum by electrolytic methods directly from scheelite concentrates.	Project completed, end of 1961-62. Highly useful techniques developed. Information published by the U.S. Bureau of Mines as: R.I. 5554. Electrowinning tungsten and associated molybdenum from scheelite. 1959. R.I. 5795. Electrowinning molybdenum, preliminary studies. 1961. R.I. 6512. Electrolytic extraction of tungsten from western scheelite. 1964.
Utilization of large deposits of anorthosite from the San Gabriel Mountains in southern California for the possible production of alumina, titanium, iron, and other co-products.	Project completed, end of 1960-61. Technique developed which most certainly will be used in the future for alumina recovery. Information published by the U.S. Bureau of Mines as: R.I. 6288. Recovery of alumina from anorthosite, San Gabriel Mountains, California, using the lime soda sinter process. 1963.
Mining research in problems of slope stability and characteristics of structural aspects of mines, effect of unloading of rock, etc.	Project completed in California, end of 1962-63. Slope failure detection devices developed and tested at Boron. Similar techniques now being used in Nevada and elsewhere. Information on underground research published by U.S. Bureau of Mines as: R.I. 6110. Underground borate mining, Kern County, California. 1962. Describes factors that affect the structural characteristics of mines.
Chromium research aimed at the extraction of chromium metal or compounds from concentrates of domestic chromite-type ores by fused salt electrolytes	The project was concluded, at least on a cooperative basis, at the end of 1964-65. The results demonstrated the feasibility of electro-preparation of a premium grade of 80% ferrochromium directly from substandard material prepared by smelting domestic chromite concentrates.

Table 3 Continued

Project	Results
Mineral reconstitution research aimed at the reconstitution of ferroalloy minerals by the controlled heating and cooling to form crystals that may be more amenable to mechanical recovery by other applicable techniques.	Project continued at reduced rate in 1964-65 and recessed prior to 1965-66. Results, using low-grade iron materials (example: high-iron lateritic material) and low-grade manganese ores, have not been encouraging.

The metallurgical phase of the cooperative program was discontinued as of 1965-66 in order to divert funds within Division's allocation to other purposes.

Table 4

RESOURCE INVESTIGATION PROJECTS BY THE U.S. BUREAU OF MINES
SUPPORTED UNDER MATCHING FUND CONTRACT WITH DIVISION OF MINES AND GEOLOGY, 1959-1966

Project	Results
Investigation (drilling and sample testing) of nickel and chromium potential of lateritic materials in northern California. Attempt to determine presence of economic deposits in California similar to those at Riddle in southern Oregon.	Information was made available to Division geologist and was utilized in Division investigations (samples tested, etc.). U.S. Bureau of Mines published: R.I. 6206. Pine Flat and Diamond Flat nickel-bearing laterite deposits, Del Norte County, California. 1963.
Investigation and evaluation of large clay deposits in San Gabriel Mountains, California (Binford deposits).	Project completed, 1963. Information placed on open file. Property owners informed. (Test work on this clay also performed by University of California under cooperative agreement.)
Investigation (drilling and sample testing) of Indian Diggings limestone deposit, El Dorado County.	Project completed, 1963. Information incorporated by Division geologist in Special Report in press, "Geology of limestone deposits in the Omo Ranch quadrangle, El Dorado County, California." U.S. Bureau of Mines provided the Division with an open file report dated 1964, "Investigation of the Indian Diggings limestone deposits, El Dorado County, California."
Investigation (drilling and sample testing) of Rush Creek sanbornite deposits, Fresno County.	Project completed, 1963. U.S. Bureau of Mines provided the Division with open file report dated 1964, "Investigation of the Rush Creek sanbornite deposit, Fresno County, California." In addition to the sanbornite, a barium silicate having some economic possibilities, the investigations led to the discovery of seven new barium minerals. Division geologists have Special Report in progress on the geology of these deposits. Descriptive reports on the seven new minerals were published in Mineral Information Service (Vol. 17, No. 12, 1964, and Vol. 18, No. 2, 1965) on "New minerals from Fresno County, California." The technical mineralogical description of these new minerals was published in the American Mineralogist, the Journal of the American Mineralogical Society.

Table 4 Continued

Project	Results
Investigation (drilling and sample testing) of the mineral resources of the Cherokee hydraulic pit area, Butte County.	Drilling completed, 1962; test work nearly completed; U.S. Bureau of Mines preparing report for Division use on "Investigation of sands and clays of the Cherokee area, Butte County, California." Division geologist preparing economic geologic report on the project, incorporating Bureau data; but work recessed to complete other pressing assignments. (supplementary clay test work also in progress by University of California under cooperative agreement)
Investigation (drilling and sample testing)of the clay resources of the Cooperstown-La Grange area, Stanislaus County.	Drilling and Bureau test work completed, 1963 (additional and supplementary clay test work in progress by University of California under cooperative agreement). U.S. Bureau of Mines prepared report for Division's open file, "Bucket drilling the Cooperstown extension of the Ione clay deposits, Stanislaus County, California." Division geologist preparing geologic report for Special Report series.
Ogilby kyanite deposits, Imperial County.	Investigation completed, 1963. Test work--beneficiation, ceramic tests, and analytical work--completed, 1963. Information placed on open file in Division offices.
Investigation (drilling and sample testing) of clay resources of Castle Mountains area, San Bernardino County.	Initial drilling and test work completed, 1963. Division geologist continuing geologic investigation in area and other test sites may be selected. Information developed to date on open file. (supplementary clay testing being done by University of California on cooperative agreement)
Molybdenite.	Samples of possible interest for molybdenum content taken by Division geologist from deposits in San Diego County. Samples analyzed for molybdenum and rhenium. Information provided to Division geologist.
Investigation of pozzolanic materials in California--a statewide study.	Project initiated 1963; continuing 1966-67. Division geologist supervised sampling program; Bureau provided extensive laboratory test work--petrographic, chemical, mortar bar; mortar bar testing continued 1965-66. Additional sampling may be necessary 1966-67 after initial test results analyzed. Additional mortar bar tests may be performed 1966-67.

Table 4 Continued

Project	Results
Barite investigations (Shasta County project--drilling and sample testing)	One drilling project completed, 1964. Sample testing completed by Bureau during 1965-66. Part of Division's statewide barite investigation. Division project geologist conducts geological investigation of barite deposits throughout state; requested drilling project on Shasta County deposit. Results to be incorporated in Bulletin to be published by the Division on "Barite deposits of California."
Marine Resources investigations	As a trial operation during 1964-65, a Division geologist obtained the cooperation of the Bureau's Marine Technology Center, Tiburon, California, in obtaining 10 bottom samples from Monterey Bay along a track designated by the geologist to obtain preliminary and reconnaissance information on the distribution of minerals in the bay sediments. The Division geologist accompanied the Bureau ship during this sampling trip. During 1965-66, funds were expended to support the Bureau's effort to develop marine sampling, testing, and mining equipment and techniques. Incidental and useful dividends were obtained in the form of bottom samples from San Francisco Bay, providing mineral resource information (shell deposits as a possible future source of $CaCO_3$) and information useful to the Division's project for the San Francisco Bay Conservation and Development Commission.
Gorman tin investigation (Tejon Ranch, Kern County project)	Drilling project completed, July 1965 (on 1964-65 cooperative contract; no funds expended 1965-66). Division geological, geophysical, and geochemical investigation of only tin-producing area in California (and U.S.) resulted in need for sub-surface data to test and check hypotheses developed to date concerning possibility of existence of additional tin-bearing deposits. Two holes, totaling 897 feet, drilled and cores subjected to analytical procedures by Division chemist during 1965-66.

U.S. Geological Survey

This cooperative program--wherein the contracting parties provide matching funds (The U.S. Geological Survey provides the personnel) and either or both contracting parties, by mutual agreement, publish the results--was initiated in 1946. During the first six years of the agreement, $50,000 was provided by each party; $35,000 for the next nine years; and $30,000 since. The agreement originally was keyed primarily to field mapping and laboratory investigation of quadrangles in the principal mining districts of California and was designed to yield basic, detailed information on those areas in which minerals of possible economic value occur. During the past few years, however, projects have been included to develop basic geologic information for reasons other than the mineral potential of the district alone. The probability that geologic hazards exist within the area is one of the more important criteria that will be increasingly emphasized in the selection of projects for the cooperative program in future years.

The matching-funds provision allows the Division to materially increase information on California geology at a cost lower than would result if the Division conducted its own investigations.

Since the initiation of the cooperative program early in 1946, the Division has issued 28 publications as direct products of the cooperative work. An equal number or more of supplemental, not duplicative, publications have been issued by the U.S.G.S. or various geological societies, releasing the results of the cooperative projects.

Publications released by the Division of Mines and Geology, resulting from U.S.G.S. cooperative program:

1. Copper in California; Bulletin 144, 1948; J.H. Eric et al.

2. Geology of limestone near Sonora, Tuolumne County; California Jour. Mines and Geology, v. 45, no. 4, 1949; G.R. Heyl and J. H. Wiese.

3. Geology of limestone near Gazelle, Siskiyou County; California Jour. Mines and Geology, v. 45, no. 4, 1949; G.R. Heyl and G.W. Walker.

4. Geology of the Electra and West Point Tunnels, Amador County; California Jour. Mines and Geology, v. 46, no. 1; J.H. Wiese et al.

5. Sierra Blanca limestone in Santa Barbara County; Special Report 1A, 1950; G.W. Walker.

6. The Calera limestone in San Mateo and Santa Clara Counties; Special Report 1B, 1959; G.W. Walker.

7. Gem- and lithium-bearing pegmatites of the Pala district, San Diego County; Special Report 7A, 1951; R.H. Jahns and L.A. Wright.

8. Economic geology of the Rincon pegmatites, San Diego County; Special Report 7B, 1951, J.B. Hanley.

9. Geology of the massive sulfide at Iron Mountain, Shasta County; Special Report 14, 1951; A.R. Kinkel, Jr., et al.

10. Geology of the Shasta King mine, Shasta County; Special Report 16, 1951; A.R. Kinkel, Jr., and W.E. Hall.

11. Suggestions for exploration at New Almaden quicksilver mine, Special Report 17, 1952; E.H. Bailey.

12. Rocks and structure of the Quartz Spring area, northern Panamint Range; Special Report 25, 1952; J.F. McAllister.

13. Geology of the Mammoth mine, Shasta County; Special Report 28, 1952; A.R. Kinkel, Jr., and W.E. Hall.

14. Geology and ore deposits of the Afterthought mine, Shasta County; Special Report 29, 1953; J.P. Albers.

15. Geological investigations of strontium deposits in Southern California; Special Report 32, 1953; Cordell Durrell.

16. Geology of the Santa Rosa lead mine, Inyo County; Special Report 34, 1953; E.M. Mackevett.

17. Geology of the Calaveritas quadrangle, Calaveras County; Special Report 40, 1955; L.D. Clark.

18. Geology of Angels Camp and Sonora quadrangles, Calaveras and Tuolumne Counties; Special Report 41, 1955; J.H. Eric et al.

19. Geology of mineral deposits in the Ubehebe Peak quadrangle, Inyo County; Special Report 42, 1955; J.F. McAllister.

20. Economic geology of the Bishop tungsten district, Special Report 47, 1956; P.C. Bateman.

21. Economic geology of the Casa Diablo Mountain quadrangle; Special Report 48, 1956; C.D. Rinehart and D.C. Ross.

22. Economic geology of the Darwin quadrangle; Special Report 51, 1958; W.E. Hall and E.M. Mackevett.

23. Geologic reconnaissance of the northern Coast Ranges and Klamath Mountains; Bulletin 179, 1960; W.P. Irwin.

24. Economic geology of Panamint Butte quadrangle; Special Report 73, 1963; W.E. Hall and H.G. Stephens.

25. Geology and mineral deposits of Mount Diablo; Special Report 80, 1963; E.H. Pampeyan.

26. Franciscan and related rocks and their significance in the geology of western California; Bulletin 183, 1964; E.H. Bailey, W.P. Irwin, D.L. Jones.

27. Economic geology of French Gulch quadrangle; Special Report 85, 1965, J.P. Albers.

28. Chromite deposits of Shasta, Tehama, Trinity, and Humboldt Counties, California; Bulletin 134, Part 28, Chapter 3, 1965; F.G. Wells and H.E. Hawkes.

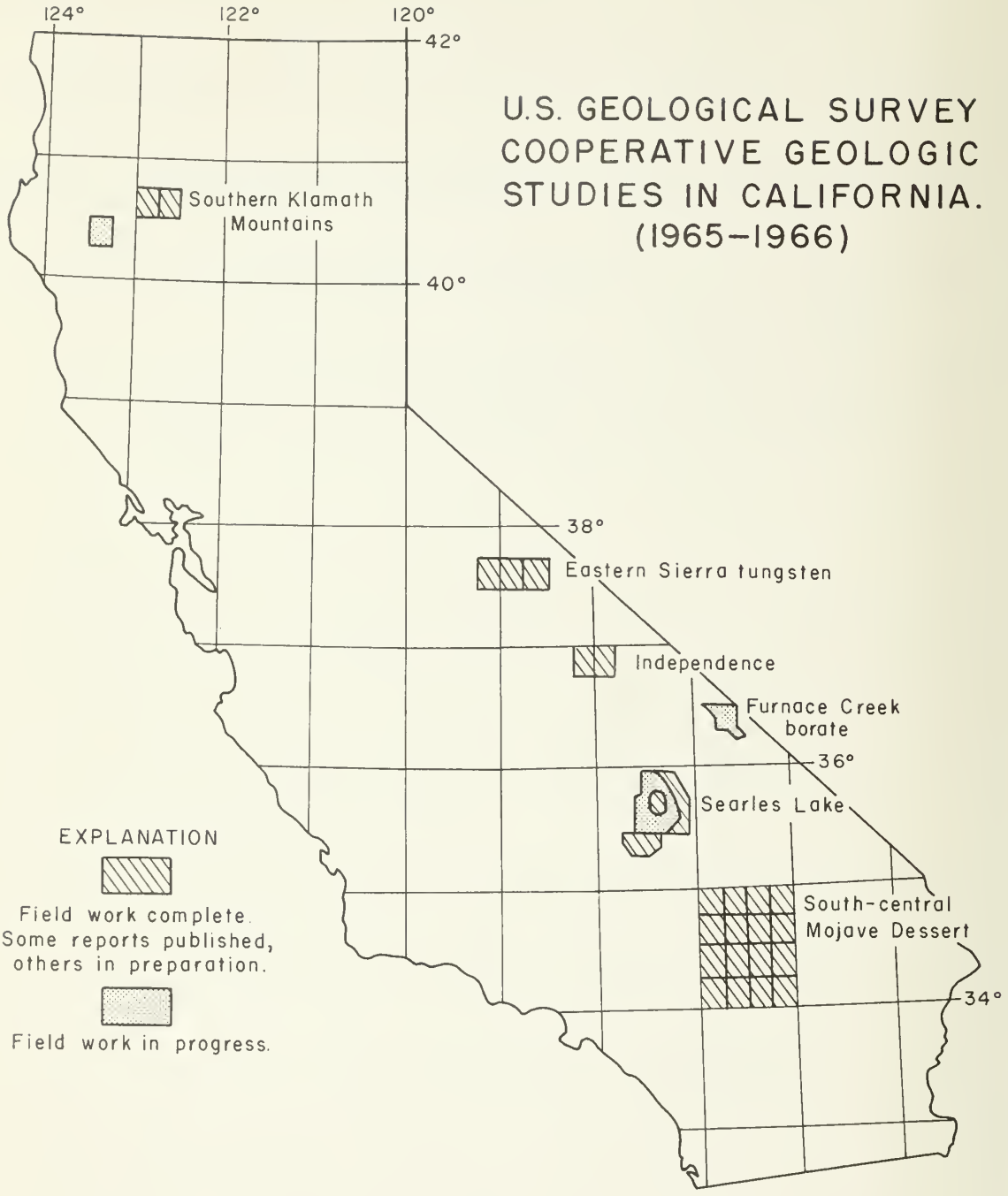

U.S. GEOLOGICAL SURVEY
COOPERATIVE GEOLOGIC
STUDIES IN CALIFORNIA.
(1965–1966)
124°
122°
120°
42°
40°
38°
36°
34°
Southern Klamath
Mountains
Eastern Sierra tungsten
Independence
Furnace Creek
borate
Searles Lake
South-central
Mojave Dessert
EXPLANATION
Field work complete.
Some reports published,
others in preparation.
Field work in progress.

Table 5

PROJECTS ACTIVE UNDER THE COOPERATIVE PROGRAM, JULY 1, 1966

Project	Accomplishments and Status	Product Completed	Product in Press	Report in Preparation
1. Furnace Creek Borates	Completed geologic mapping of the Ryan 15-minute quad. Mapped new underground workings of Kern Borate Mine to bring geologic maps of mines up to date. Mapping of area adjacent to Ryan quad in progress.	1. Open file report on Furnace Creek borate district filed--DMG. 2. Stratigraphic distribution on the Late Cambrian Mollusk Mattheyia. (USGS Prof. Paper 525-B)		Geologic map and report of Furnace Creek borate area.
2. Searles Lake Boron	Geologic mapping of Late Cenozoic deposits in Searles Valley nearly completed.	1. Left-lateral displacement on the Garlock fault. (abstract published in AAPG) 2. Geology and petrology of the Lava Mountains, San Bernardino County, California. (USGS Prof. Paper 457) 3. Character and distribution of nonclastic minerals in the Searles Lake evaporite deposit, California. (USGS Bulletin 1181-P)	1. Geology of Slate Range, San Bernardino and Inyo Counties (DMG)	

Table 5 Continued

Project	Accomplishments and Status	Product Completed	Product in Press	Report in Preparation
		4. Mineral equilibria in the Searles Lake evaporites, California. (Jour. Petrology)		
		5. Geologic and climatic history of Searles Lake; paper presented at International Quaternary Assoc., 7th Cong. (abs.)		
		6. Geology of Slate Range, San Bernardino and Inyo Counties; paper presented at meeting of Rocky Mountain Section, GSA.		
		7. Guide to geology of Searles Valley; for International Quaternary Association field trip.		
		8. Geochemistry of Searles Lake, California; paper presented at Mojave Section of the American Institute of Chemical Engineers.		

Table 5 Continued

Project	Accomplishments and Status	Product Completed	Product in Press	Report in Preparation
3. Southern Klamath Mountains	Geologic mapping is continuing in Pickett Peak quad.	1. Preliminary geologic map of the Weaverville quad. (MF 275 by USGS) 2. Geology of French Gulch quad. (USGS, GQ-336) 3. Geology of French Gulch quad. (USGS Bull. 1141-J) 4. Franciscan and related rocks and their significance in the geology of western California. (DMG Bull. 183) 5. Late Mesozoic orogenies in the ultramafic belt of northern California and southern Oregon. (USGS Prof. Paper 501-C) 6. Economic geology of French Gulch quad. (DMG Special Report 85) 7. Radiometric age of Salmon Hornblende Schist and Abrams Mica Schist. (USGS Prof. Paper 525-D)	1. Geology of the Klamath Mountains. (DMG) 2. Klamath Mountains province (chapter in Senate document--Kuchel volume)	1. Geology of the Weaverville quad.

Table 5 Continued

Project	Accomplishments and Status	Product Completed	Product in Press	Report in Preparation
4. South Central Mojave Desert	Geologic mapping of 16 15-minute quads (about 4,000 sq. miles). Field work in entire area completed except for parts of the Daggett quad.	1. Geologic map of Lucerne Valley quad. (USGS I-426) 2. Geologic map of Ord Mountains quad. (USGS I-427) 3. Geologic map of Rodman Mountains quad. (USGS I-430) 4. Geologic map of San Gorgonio quad. (USGS I-431) 5. Geologic map of Newberry quad. (USGS I-461) 6. Geologic map of Cady Mountains quad. (USGS I-467) 7. Geologic map of Lavic quad. (USGS I-472)	1. Geologic map of Broadwell Lake quad. (USGS MGI Map) 2. Geologic map of Ludlow quad. (USGS MGI Map) 3. Geologic map of Deadman Lake quad. (USGS MGI Map)	Geologic maps of Old Woman Springs, Morongo Valley, Daggett, Joshua Tree, and Twenty-Nine Palms quads.
5. Independence and Waucoba Wash Quads	Mapping completed in Waucoba Wash quad to complete field work of project.	1. New Cambrian, Ordovician, and Silurian formations in Independence quad, Inyo County. (USGS Prof. Paper 475-B)	1. Stratigraphy of some Paleozoic formations in the Independence quad, Inyo County, Calif. (USGS Prof. Paper 396)	1. Geologic map of Waucoba Wash quad. 2. Descriptive petrography of three large granitic bodies in the Inyo Mountains.

Table 5 Continued

Project	Accomplishments and Status	Product Completed	Product in Press	Report in Preparation
			2. Last Chance thrust--a major thrust fault in the eastern part of Inyo County, California. (USGS Prof. Paper 550-D in press)	3. Last Chance thrust--a major thrust fault in the eastern part of Inyo County. 4. Geologic map of the Inyo Mountain region (a compilation at 1:125,000).
			3. Geologic map of the Waucoba Wash quad, Inyo County, Calif. USGS GQ-612 being processed for publ.	
			4. Descriptive petrography of three large granitic bodies in the Inyo Mountains, California. (USGS Prof. Paper being edited for publ.)	
			5. Geologic map of the Inyo Mountains region--a 1:125,000 compilation of a 3,000-sq-mile area. (USGS MGI Map submitted for processing for publication)	
6. Eastern Sierra Tungsten	Mapping completed in Devil's Postpile quad, to complete field work of project.	1. Geology and mineral deposits of Mount Morrison quad, Sierra Nevada, California. (USGS Prof. Paper 385)	1. Geologic map of the Devil's Postpile quad. (USGS GQ-437)	1. Geology of the metamorphic rocks of the Ritter Range roof pendant, Devil's Postpile quad, California.

Table 5 Continued

Project	Accomplishments and Status	Product Completed	Product in Press	Report in Preparation
		2. Devil's Postpile National Monument, a popular geological account. (Mineral Information Service, DMG)	2. Origin of the Inyo Craters (Mineral Information Service, DMG).	
		3. Devil's Postpile National Monument. (USGS Map GQ-437)	3. Geology of the Cenozoic volcanic rocks of the Devil's Postpile quad, California. (USGS Prof. Paper)	
		4. Some relationships between the refractive index of fused glass beads and the petrologic affiliates of volcanic rock suites. (GSA Bulletin)		

University of California

For several years, the Division of Mines and Geology has allocated funds for a cooperative program with the Department of Mineral Technology, University of California, Berkeley, for testing and research on clay and other ceramic raw materials.

Informal cooperation between the Division of Mines and Geology and the Department of Mineral Technology on studies of California clays and other non-metallic raw materials began in 1948-1949. Because of expanding activities, the arrangement was formalized in 1953-54 in a contract between the two institutions, principally to provide funds in support of laboratory work to be done at the University. Each year since then this agreement has been continued.

The need for this program stems from the nature of these materials. Because of their extremely fine-grained character, they often cannot be studied by direct methods; and, unlike many mineral materials, relatively little can be told about them by ordinary microscopic studies. In the past three or four decades, special techniques have been developed which have revolutionized the study of the clay minerals. Among these are X-ray diffraction, differential thermal analysis, electron microscopy, and infrared spectroscopy.

The University, in its Ceramic Engineering Laboratory, has built up a reservoir of highly trained specialists and advanced research equipment for the study of clays and related materials and is one of the few institutions in the country that have such facilities. By this cooperative agreement, the Division has been able to get technical data, as well as ceramic test information, and has benefited from interpretations and discussions of these data provided by the University's specialists. This information has been combined with the Division's own studies of geologic occurrence of the deposits and has greatly contributed to the usefulness of the Division's published reports. In addition, University personnel have investigated various special problems under the program and, in addition to outside publication or presentations, have provided the Division with the results.

A complete list of the projects included in this cooperative program since its inception follows:

STUDY	RESULTS
1. Clay Committee: an active group concerned with the diffusion of clay knowledge; made up of representatives from U.C. staff, U.S. Geological Survey, U.S. Bureau of Mines and State Division of Mines and Geology plus occasional representatives from industry.	Organizes conferences, acts as a clearing house for information on clay and provides a means of discussing mutual problems.
2. Geology and ceramic properties of the Ione clays in the Buena Vista area, Amador Co., California.	Project completed; results reported in Division of Mines Special Report 19, 1952.
3. Relation of the geology of Ione clays to their ceramic properties.	Project completed; results reported at the 1954 meeting of the American Ceramic Society.
4. Determination of the ceramic properties of certain volcanic materials in the Barstow quadrangle.	Project completed; results reported in Division of Mines Bulletin 165, 1954.
5. Determination of differences between different types of perlite.	Considerable data developed for use in special perlite study.
6. Report of the First National Clay Conference held in Berkeley.	Project completed; results reported in Division of Mines Bulletin 169, 1955.
7. Short articles on clay and clay education.	Articles presented in Division of Mines monthly publication, Mineral Information Service, July, August, 1952; June, 1955.
8. Report from the Industrial Clay Conference held in Berkeley.	Project completed; papers reported in California Journal of Mines and Geology, April 1956.

STUDY	RESULTS
9. Summary report on clay resources of California, for mineral commodity bulletin.	Data provided to Division staff for report published in Division Bulletin 176, 1957.
10. Effect of mineral composition on strength of central California sediments.	Project completed; results reported in California Journal of Mines and Geology, April 1958.
11. Road log for Ione field trip, Sixth National Clay Conference, Berkeley, 1957.	Project completed; published in National Academy of Sciences, National Research Council proceedings volume, 1959.
12. Geology of the Otay bentonite deposit, San Diego County, California.	Project completed; results reported in Division Special Report 64, 1960.
13. Testing and evaluation of samples from the Binford clay deposit, Los Angeles County, California.	Project completed; data correlated with U.S. Bureau of Mines evaluation. Information on open file and property owner advised.
14. Geology of the Little Antelope Valley clay deposits, Mono County, California.	Project completed; results reported in Division Special Report 72, 1962.
15. Identification of non-quartz finely-divided silica and other fractions in certain California clays.	Project completed; results reported in proceedings volume, 1963 National Clay Conference.
16. Relations of mineral composition and water content to rheological properties of clay-water systems.	Project completed; results reported at 1964 National Clay Conference.
17. Relationship of weight-loss to temperature in study of newly-discovered barium silicate mineral.	Project completed; results reported in American Mineralogical Society Bulletin, volume 50, no. 3-4 (March-April, 1965).

STUDY	RESULTS
18. An analysis of the influence of physical-chemical factors upon the consolidation of fine-grained clastic sediments.	Project completed; results to be reported in American Association of Petroleum Geologists Symposium volume.
19. Expansible shale resources of the San Jose area, Santa Clara County, California.	Project completed; results published as Division Special Report 87.
20. Testing and evaluation of clays from Cherokee hydraulic pit, Butte County, California.	Project temporarily suspended; investigator involved with other assignments.
21. Geology and clay deposits of the Cooperstown-La Grange area, Stanislaus County, California.	Project temporarily suspended; investigator involved with other assignments.
22. Road log for Lincoln and San Francisco Bay Area field trips, 14th North American Clay Conference, Berkeley, 1965.	Project completed; published as separate field trip guidebook.
23. Design and construction of differential thermal analysis furnace, and technical assistance on control and recording equipment for Division laboratory.	Project completed; equipment installed in Division laboratory in San Francisco.
24. Nature of the clay material "anauxite" in the Ione clay deposits.	Project nearly complete; report expected in Fall, 1966.
25. Viscosity and activation energy study of clay-water systems.	Project initiated, results to be reported as Division short paper.
26. Atomic absorption determinations of elements in certain minerals.	Obtained special cathode tubes and standard solutions to adapt University atomic absorption spectrophotometer for special project by Division investigator.

STUDY	RESULTS
27. Geology and clay resources of the Castle Mountains area, San Bernardino County, California.	Project being resumed, as investigator becomes available on completion of other assignments.

Los Angeles County

Large-scale (one inch to 800 feet) geologic mapping continued in the San Gabriel Foothills in Los Angeles County in cooperation with the Los Angeles County Flood Control District and the Los Angeles County Engineer. These two agencies together supplied half the funds for these projects while the Division supplied the other half. By the close of the triennium on June 30, 1966, field work on the western San Gabriels project, including parts of Azusa and Mt. Wilson 7 1/2-minute quadrangles, was complete; and preliminary versions of the Azusa quadrangle maps released on open file. Laboratory work and final writing of the report were under way for publication. In the eastern San Gabriels project, preliminary maps of the south half of Glendora 7 1/2-minute quadrangle were placed on open file during the triennium; and mapping of the SW 1/4 of the Mt. Baldy 7 1/2-minute quadrangle was about half done as of July 1, 1966. The detailed field map of the Palos Verdes Hills, completed prior to 1963, remained on open file while map revisions were in process and the final report was in preparation for publication.

City of San Diego

On July 1, 1965, the Division began the first phase of a three-year cooperative project, sharing 50-50 with the City of San Diego the cost of making large-scale geologic maps of major portions of the city and identifying geologic engineering problems. By July 1, 1966, a Division geologist had nearly completed 1/2-mile-to-the-inch geologic maps of the selected areas; had solved several geologic problems; and had identified several problem areas that require geologic work in greater detail, at scale 800 feet to the inch or larger, as the second phase of the project.

Other Cooperative Programs

The Division of Mines and Geology continued to cooperate with a number of State and Federal agencies and with individuals under informal administrative agreements, without written contracts, and without matching funds. The State Department of Water Resources and the Division of Highways used information supplied by the Division of Mines and Geology; and each furnished information useful to the Division, particularly in compiling the 1:250,000-scale Geologic Map of California. The Division cooperated with the Department of Parks and Recreation by preparing and publishing geologic descriptions of

State Parks such as Pt. Lobos Reserve and MacArthur-Burney Falls. In February, 1966, the Division assigned one geologist full-time to evaluating subdivision proposals on a liaison agreement with the Division of Real Estate.

Cooperation continued with the University of California Seismograph Station, E.S.S.A., Coast and Geodetic Survey, the Pacific Fire Rating Bureau, and the Earthquake Engineering Research Institute on investigations of recent faulting and earthquakes in the state. Particular attention was paid to the San Andreas fault because of repeated earthquakes along it and because it is an important threat to the location of large engineering structures.

The Division assisted the Committee on Lateral Faulting of the American Association of Petroleum Geologists with information on faults and faulting in California and cooperated with the Geological Society of America as a participating organization for annual meetings and production of the guidebook "Geology of Northern California", Bulletin 190, 1966.

Division geologists cooperated in studying the safety of nuclear sites as members of the Governor's Special Hazards Committee, the Resources Agency Committee on Nuclear Siting, and the American Institute of Professional Geologists Committee on the Geologic Environment in the City of Los Angeles. Division administration and staff continued traditional close working relationships with earth scientists of the geology departments of many California universities including sampling studies in granitic rocks with Pomona College staff; cooperative geophysical investigations with staff of Stanford University, California Institute of Technology, and University of California at Riverside; studies of landslides in the Los Angeles area with geologists of Whittier College; and preparation of a new edition of "Minerals of California" with mineralogists of the University of California at Santa Barbara and at Los Angeles.

Cooperation continued with the U.S. Forest Service and the U.S. Bureau of Land Management -- chiefly in the areas of mineral leasing, mining law, rights to mineral location, Division records of mining claims, and determining the most desirable boundaries of proposed withdrawals. In 1965, the Division cooperated with the working committee of the Federal Appalachian Strip and Surface Mine Study in preparing a statewide survey of areas where mining has resulted in the disfiguring of the surface.

Long-standing cooperation with the California Academy of Sciences continued in fields of minerals research, meteorite investigations, instrumentation, and preparation of mineral exhibits at the Academy.

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